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PALMERTON & PARRISH, INC.

GEOTECHNICAL & MATERIALS ENGINEERS
MATERIALS TESTING LABORATORIES
ENVIRONMENTAL SERVICES

4168 W. Kearney St.
Springfield, MO 65803
Ph: (417) 864-6000
www.ppimo.com

December 5, 2022

Childers Architect
142 Howell Street, Suite 170
Dallas, Texas 75207

Attn: Mr. Matthew Thomas, Associate AIA
Email: mthomas@childersarchitect.com

RE: All Geotechnical Engineering Documents Combined
W.W. Hastings Replacement Hospital
Tahlequah, Oklahoma
PPI Project Number: 277340 & 280212

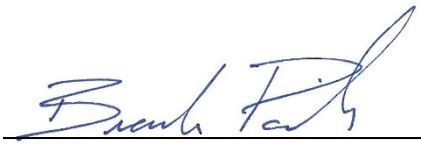
Dear Mr. Thomas:

As requested by you, the purpose of this letter was to combine all Geotechnical Engineering Documents prepared by PPI for the above referenced project for bidding purposes. The documents attached to this letter include the following:

- Initial Geotechnical Engineering Report dated February 9, 2022 (PPI Proj. No. 277340);
- Addendum No. 1 to Geotechnical Engineering report dated August 18, 2022 (PPI Proj. No. 277340);
- Addendum No. 2 to Geotechnical Engineering report dated November 9, 2022 (PPI Proj. No. 277340); and
- Pier Pre-Drilling Results Summary Letter dated November 4, 2022 (PPI Proj. No. 280212).

We appreciate this opportunity to be of service and if you have any questions, please don't hesitate to contact this office.

PALMERTON & PARRISH, INC.
By:



Brandon R. Parrish, P.E.
Vice President

10000 Hwy 160
Walnut Shade, MO 65771
Ph: (417) 561-8395

3500 East 13th Street
Joplin, MO 64801
Ph: (417) 624-2005

INITIAL GEOTECHNICAL ENGINEERING REPORT
DATED: 02/09/2022

GEOTECHNICAL ENGINEERING REPORT

W.W. HASTINGS REPLACEMENT HOSPITAL

& PARKING GARAGE

TAHLEQUAH, OKLAHOMA

Prepared for:

CHILDERS ARCHITECT
142 Howell Street, Suite 170
Dallas, Texas 75207

Prepared by:

Springfield, MO
4168 W. Kearney Springfield, MO 65803
Call 417.864.6000 Fax 417.864.6004
www.ppimo.com

PPI PROJECT NUMBER: 277340

February 9, 2022

PALMERTON & PARRISH, INC.

GEOTECHNICAL & MATERIALS ENGINEERS
MATERIALS TESTING LABORATORIES
ENVIRONMENTAL SERVICES

4168 W. Kearney Street.
Springfield, MO 65803
Ph: (417) 864-6000
www.ppimo.com

February 9, 2022

Childers Architect
142 Howell Street, Suite 170
Dallas, Texas 75207

Attn: Mr. Matthew Thomas, Associate AIA
Email: mthomas@childersarchitect.com

RE: Geotechnical Engineering Report
W.W. Hastings Replacement Hospital & Parking Garage
Tahlequah, Oklahoma
PPI Project Number: 277340

Dear Mr. Thomas:

Attached, please find the report summarizing the results of the Geotechnical Investigation conducted for the above referenced project. We appreciate this opportunity to be of service and if you have any questions, please don't hesitate to contact this office.

PALMERTON & PARRISH, INC.
By:

Shane M. Rader, P.E.
Geotechnical Engineer

PALMERTON & PARRISH, INC.
By:

Brandon R. Parrish, P.E.
Vice President

02/09/22

Submitted: One (1) Electronic .pdf Copy

BRP/SMR/brp

PALMERTON & PARRISH, INC.

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EXECUTIVE SUMMARY

A Geotechnical Investigation was performed at the site planned for construction of the new Cherokee Nation W.W. Hastings Replacement Hospital and Parking Garage located directly east of the recently constructed Cherokee Nation Outpatient Health Center in Tahlequah, Oklahoma. This project is anticipated to include construction of a new Hospital, Parking Garage and Central Energy Center. The new hospital is anticipated to be up to eight (8) stories in height with many areas only one (1) to five (5) stories in height, steel framed, utilize a slab-on-grade floor system, exhibit light to heavy foundation loads, and measure approximately 100,000 sq. ft. in plan view. In addition to the hospital, a new ten (10) level parking garage with 1,526 parking spaces and a two (2) story, free standing central energy center measuring 12,800 sq. ft. are planned at the site. The parking garage is anticipated to exhibit heavy foundations loads, with column loads in excess of 1,000 kips. Previous grading has been performed at the site. Approximately 2 to 6 ft. of additional fill is anticipated to be required within the Replacement Hospital footprint, while +/- 1 ft. of cut/fill is anticipated within the footprint of the parking garage and central energy center.

A total of twenty-six (26) geotechnical borings were drilled within the proposed development footprint. Thirteen (13) borings were located within the proposed hospital footprint, while nine (9) borings were located within the proposed parking garage. An additional four (4) borings were drilled within the proposed central energy center footprint. All borings were discontinued in natural overburden soils, chert, limestone or shale at depths ranging from 25.2 ft. to 50.0 ft. below the existing ground surface.

Based upon the information obtained from the borings and subsequent laboratory testing, the site is suitable for construction of the proposed new W.W. Replacement Hospital, Parking Garage and associated infrastructure. Important geotechnical considerations for the project are summarized below. However, users of the information contained in the report must review the entire report for specific details pertinent to geotechnical design considerations.

- The project site primarily consists of a gently sloping, concrete paved parking lot with grass covered islands, serving for the existing Outpatient Health Center;

EXECUTIVE SUMMARY (CONTINUED)

- Thin topsoil (~2 inches or less) was encountered in the borings drilled within the parking lot islands. Concrete pavement ranging in thickness from 4 to 6-inches underlain by aggregate baserock was encountered within the remaining borings drilled;

- Overburden soils generally consisted of chert gravels and sands, gravelly clays or fat clays as is typical in the Tahlequah area. These soils were primarily logged as stiff to very stiff or dense to very dense and sometimes exhibited significant drilling difficulty when using standard drilling methods. Bedrock consisting of shale or limestone was encountered within the southeast half to two-thirds of the proposed hospital footprint. The remaining borings within the hospital and all other areas generally consisted of more typical clayey gravels and solid chert. **The bedrock consisting of shale and limestone was <u>not</u> encountered during design and construction of the adjacent Outpatient Health Center;**

- Foundation loads for the new Replacement Hospital and Central Energy Center may be supported upon shallow foundations bearing upon stiff or dense natural overburden soils, or controlled fill. However, the magnitude of the foundation loads may prohibit the use of shallow foundations. These recommendations are further discussed in Section 9.0 of this report;

- Foundation loads for the Replacement Hospital, Central Plant and Parking Garage may also be supported upon deep foundations bearing in very stiff/very dense natural overburden soils/chert or bedrock, although only one (shallow or deep) foundation type is recommended per structure unless structure design allows for some differential movement. Deep foundation recommendations are further discussed in Sections 9.2 and 9.3 of this report;

- Voids were noted in Borings 1 and 2 at depths of 21.8 and 21.9 ft. below the ground surface. Drilled piers or driven piles in this area should bear through the void areas and bear on competent bedrock or chert. Additionally, deep

foundations surrounding Borings 1 and 2 should be proof-tested as described in Section 9.2 for drilled piers or Section 9.3 for driven piles;

- Due to the stiff and/or dense nature of the existing subgrade soils, sufficient support is anticipated to be provided for any slabs or pavements if subgrades are prepared in accordance with Section 8.0;
- The project site classifies as a Site Class C in accordance with Section 1613 of the 2018 International Building Code (IBC), as determined by on-site shear wave velocity testing;
- All foundation recommendations presented in this report are based upon Allowable Stress Design (ASD) methodology using unfactored loads;
- Excavation and mass earth moving at this project site is anticipated to generally be difficult and variable. Excavation difficulty and rippability of the existing overburden soils at the site is further discussed in Section 8.6 of this report; and
- Palmerton & Parrish, Inc. should be retained for construction observation and construction materials testing. Close monitoring of subgrade preparation work is considered critical to achieve adequate foundation and subgrade performance.

GEOTECHNICAL ENGINEERING REPORT

W.W. HASTINGS REPLACEMENT HOSPITAL & PARKING GARAGE

TAHLEQUAH, OKLAHOMA

1.0 INTRODUCTION

This is the report of the Geotechnical Investigation performed at the site planned for construction of the new Cherokee Nation W.W. Hastings Replacement Hospital and Parking Garage in Tahlequah, Oklahoma. This investigation was authorized by Mr. J. Breck Childers, Managing Principal, representing Childers Architect. The approximate site location is shown below for reference.

The purpose of the Geotechnical Investigation was to provide recommendations for foundation design and construction planning, and to aid in site development. Palmerton & Parrish Inc.'s (PPI) scope of services included field and laboratory investigation of the subsurface conditions in the vicinity of the proposed project site, engineering analysis of

the collected data, development of recommendations for foundation design and construction planning, and preparation of this engineering report.

2.0 PROJECT DESCRIPTION

Item	Description
Site Layout	See Figure 1: Boring Location Plan
New Replacement Hospital	• Up to eight (8) stories in height with many areas only one (1) to five (5) stories; • Steel framed; • Moderate to heavy foundation loads anticipated; • Slab-on-grade floor system w/ no basement; • Finish Floor Elevation = 919.0; and • Measure approximately 100,000 sq. ft. in plan view.
New Parking Garage	• Up to ten (10) levels in height; • 1,526 parking spaces; • Pre-cast concrete construction; • Bottom level to approximately conform to existing elevations; and • Heavy foundation loads anticipated.
Central Energy Center	• Up to two (2) stories in height; • 12,800 sq. ft. in plan view; • Steel framed; • Consist of a Generator, Cooling Towers, Water Tower & other structures; and • Light to moderate foundation loads anticipated.
Anticipated Grading	Previous grading has been performed at the site. Approximately 2 to 6 ft. of fill is anticipated to be required within the Replacement Hospital footprint, while +/- 1 ft. of cut/fill is anticipated within the footprint of the parking garage.

3.0 SITE DESCRIPTION

Item	Description
Township/Range/Section	17N/22E/34
County	Cherokee
Latitude/Longitude (± Center of Project Site)	35.911599° / -94.945351°
Available Historic Aerial Photography	The project site consisted of grass/wooded areas since prior to 1995 to 2017. In 2017 earthwork for the Outpatient Health Center began. Once complete, the area has been a concrete paved parking lot.
Current Ground Cover	Concrete pavement with grass covered islands.
Existing Topography	Gently sloping to the south.
Drainage Characteristics	Fair.

4.0 BACKGROUND INFORMATION

PPI performed the geotechnical investigation for existing Cherokee Nation Outpatient Health Center located to the west of the proposed project site. During this investigation, only minor voids at significant depth were noted in the borings drilled, similar to the borings drilled for this project. However, during mass grading for the Outpatient Health Center project, significant voids were noted to the south and southeast of the proposed project site during construction of Hospital and Visitors Drive. This condition and the potential for voids in the subsurface at the Replacement Hospital/Parking Garage site is discussed in later sections of this report.

5.0 SUBSURFACE INVESTIGATION

Subsurface conditions were investigated through completion of subsurface borings and subsequent laboratory testing.

5.1 Subsurface Borings

A total of twenty-six (26) borings were drilled at the project site. Borings were identified as presented in the following table and are shown on Figure 1: Boring Location Plan. Boring locations were selected by the Design Team and staked in the field by PPI.

Borings	Location
1 thru 13	Replacement Hospital
20 thru 28	Parking Garage
29, 30, 32 & 33	Central Energy Center

Borings were discontinued in chert, shale or limestone or natural overburden soils at depths ranging from 25.2 ft. to 50 ft. below the existing ground surface. The Oklahoma One-Call System, as well as hospital maintenance personnel, were notified prior to the investigation to assist in locating buried public and private utilities, respectively. Logs of the borings showing descriptions of soil and rock units encountered, as well as results of field and laboratory tests and a “Key to Symbols” are presented in Appendix I. Surface elevations for each boring are noted on each boring log. Surface elevations were determined in the field using RTK GPS units

and referencing on-site benchmark LLS-3104. Surface elevations are anticipated to be within an accuracy of 0.5 ft. or less.

Borings were drilled between December 1 and 22, 2021 using 4.25-inch I.D. hollow stem augers or a 3.625-inch tricone with wash rotary methods. All borings were drilled by an ATV-mounted CME-1050 or track-mounted CME-55 drill-rig. Soil samples were collected at 2.5 to 10-ft. centers during drilling, depending upon the material encountered. Soil samples were collected using either a split spoon sampler while performing the Standard Penetration Test (SPT) in general accordance with ASTM D1586, or thin-walled Shelby tubes pushed hydraulically in advance of drilling in accordance with ASTM D 1587.

When bedrock was encountered within borings 1 thru 6, 8, 9 and 13, rock coring was performed using a wireline core barrel and a diamond impregnated core bit. The rock core obtained was placed in core boxes in the order of recovery. Borings 2 and 9 encountered conditions of bedrock over chert and clayey gravels. Where this was encountered, rock coring procedures were terminated and advancement with rotary drilling techniques with sampling were implemented.

The percentage of core retrieved from each coring interval or “run” is recorded on the log forms. In addition, the rock quality designation (RQD) of the rock core was determined. “RQD” is determined by dividing the sum of the length of all individual pieces of rock core 4 in. or longer by the length cored in a single run. Bedrock with RQD values of 90 percent or more is termed excellent, 75 to 90 percent good, 50 to 75 percent fair, 25 to 50 percent poor, and 0 to 25 percent very poor. Please refer to Appendix II for general notes regarding boring logs and additional soil sampling information. Rock core photographs are attached as Appendix IV.

5.2 Laboratory Testing

Collected samples from the borings were sealed and transported to the laboratory for further evaluation and visual examination. Laboratory soil testing included the following:

- Moisture Content (ASTM D2216);

- Percent Passing No. 200 sieve (ASTM D6913);
- Atterberg Limits (ASTM D4318);
- Unconfined Compressive Strength (ASTM D2166);
- Swell Test (ASTM D4546); and
- Pocket Penetrometers.

Laboratory soil test results are shown on each boring log in Appendix I and are summarized in the following tables.

Soil Laboratory Testing Results

Boring	Depth (ft.)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Moisture Content (%)	USCS Symbol	% Passing No. 200 Sieve	Dry Density (pcf)	Cohesion (psf)
1	6-8	-	-	-	20.9	CH	-	105.6	10,179
2	3.5-5	47	15	32	12.4	CL-CH	-	-	-
3	3.5-5	33	15	18	18.3	CL	-	-	-
4	6-7.5	40	14	26	20.7	CL	-	-	-
4	8-10	-	-	-	26.4	CH	-	95.9	2,142
7	3.5-5	-	-	-	8.8	GC	14	-	-
8	3-5	33	15	18	12.0	CL	-	122.1	10,134
8	8.5-10	-	-	-	35.4	CL-CH	-	87.3	1,461
9	6	33	12	21	16.1	CL	65	-	-
9	8	61	18	43	21.8	CH	-	101.5	2,778
9	18	-	-	-	22.6	CH	-	103.5	1,848
10	3.5	34	15	19	21.5	CL	-	-	-
11	3.5	49	15	34	26.9	CL-CH	-	-	-
11	13	-	-	-	17.1	CL-CH	-	110.5	3,230
12	8.5	-	-	-	16.8	CH	-	108.9	2,669
13	6	41	14	27	16.6	CL	-	-	-
20	3.5	-	-	-	12.0	GC	41	-	-
21	8	-	-	-	20.2	CH	-	108.9	5,135
23	6	56	18	38	23.3	CH	-	-	-
24	3	-	-	-	17.5	GC	29	-	-
29	18	-	-	-	25.3	SC	35	-	-
33	3	-	-	-	27.3	CL	53	-	-

Swell testing was performed on select samples at the project site. The table below summarizes the results of the swell testing performed. Based upon the swell testing

results below, the existing shallow soils are generally anticipated to exhibit a low swell potential.

Swell Test Results					
Boring	**Depth (ft.)**	**Moisture Content (%)**	**Dry Unit Weight (pcf)**	**Swell (%)**	**Swell Pressure (TSF)**
8	3 to 4.6	14.1	120.7	1.46	2.00
9	8 to 10	25.7	99.6	0.77	1.00

Laboratory tests performed upon the rock core retrieved included the following:

- Unconfined Compressive Strength of Intact Rock Core (ASTM D7012).

Laboratory rock core test results are summarized in the table below.

Rock Core Testing Results				
Boring	**Depth (ft.)**	**Rock Unconfined Compressive Strength (psi)**	**Relative Rock Hardness**	**Rock Type**
1	19.5	6,580	Medium Hard	Argillaceous Limestone
	23.8	8,830	Moderately Hard	Argillaceous Limestone
	32.3	6,800	Medium Hard	Cherty Limestone
2	21.8	9,173	Moderately Hard	Argillaceous Limestone
3	31.7	15,542	Hard	Limestone
4	26.8	8,909	Moderately Hard	Cherty Limestone
5	11.0	7,887	Moderately Hard	Argillaceous Limestone
6	13.4	7,051	Medium Hard	Argillaceous Limestone
	19.2	9,565	Moderately Hard	Argillaceous Limestone
8	16.3	12,893	Moderately Hard	Argillaceous Limestone
	21.5	3,662	Medium Hard	Shale
13	23.5	4,449	Medium Hard	Argillaceous Limestone
	27.8	4,164	Medium Hard	Cherty Limestone

5.3 Corrosion Testing

Corrosion testing was performed on the samples in the upper 7.5 feet of the subsurface exploration. Samples were sent to Midwest Laboratories to be performed. Below is a list of samples with their results for corrosion testing:

Corrosion Testing Results								
Boring	Depth (ft.)	Oxidation Reduction Potential (mV)	Resistivity (ohm/cm)	Sulfides	Chloride (mg/L)	Sulfate (mg/L)	Conductivity (µS/cm)	pH S.U.
2	3.5 to 7.5	342	7,090	Absent	9.6	N.D.*	141	5.69
11	3.5 to 5	316	4,500	Absent	7.6	10.6	222	6.66
*Not Detected (N.D.)								

Based on the results of the corrosion laboratory testing, the average corrosive potentials and degradation potentials of the soils are summarized in the tables below.

Corrosion Potential of Steel					
Boring	Depth (ft.)	Resistivity (ohm/cm)	Chloride (ppm)	pH S.U.	Corrosion Potential
2	3.5 to 7.5	7,090	9.6	5.69	Mild to Moderate
11	3.5 to 5	4,500	7.6	6.66	Mild to High

Degradation Potential of Concrete				
Boring	Depth (ft.)	Sulfate (ppm)	Exposure	Special Cement Type
2	3.5 to 7.5	N.D.	Mild	None
11	3.5 to 5	10.6	Mild	None

6.0 SITE GEOLOGY

According to the United States Geologic Survey's Geological Map of Oklahoma, the general site is underlain at depth by the Keokuk and Reeds Spring formation and the St. Joe Group. Within the site area, the primary rock type is chert with other rock types consisting of limestone, shale, and marlstone. Overburden soils at the site are typically residual having developed through chemical and physical weathering of the underlying parent bedrock, consisting primarily of chert fragments, boulders and clay layers. The

boundary between overburden soils and relatively unweathered limestone is usually abrupt.

7.0 GENERAL SITE & SUBSURFACE CONDITIONS

Based upon subsurface conditions encountered within the borings drilled at the project site, generalized subsurface conditions for the approximate northern ½ of the site are fairly consistent across the project site, and similar to typical overburden soils found within the Tahlequah area. Surficial materials primarily consist of thin topsoil or pavement consisting of concrete over aggregate baserock, overlying very stiff to very dense lean or fat clays. Oftentimes the percentage of clay is less than 50 percent, and the soils classify as chert gravels or sands. Zones of relatively chert free very stiff fat clays were encountered, but are believed to be isolated.

However, subsurface conditions within the approximate southern half of the project, i.e. Borings 1 thru 4, 8, 9 and 13, consist of the same soil types above except that the soils contain a reduced gravel percentage and that limestone or shale is encountered at depth, sometimes relatively shallow. **In general, subsurface conditions vary widely across the site.**

These conditions are presented on each boring log attached in Appendix I. Soil stratification lines on the boring logs indicate approximate boundary lines between different types of soil and rock units based upon observations made during drilling. In-situ transitions between soil and some rock types are typically gradual.

7.1 Limestone & Shale

Argillaceous limestone, chert and/or shale was encountered within several of the borings located within the approximate southern half of the project site. The table below summarizes depth to argillaceous limestone/shale/chert, surface elevation, core recovery and rock quality designation (RQD), if rock coring was performed.

Boring	Surface El.	Approx. Depth to Top of Rock / Rock Type (ft.)	Rock Core Retrieved (ft.)	Recovery (%) RQD (%)	Clay Seams or Voids (ft.)
1	917.0	18.2 / Shale 31.8 / Limestone	15	80-100-100 75-58-67	21.9 to 22.9 (Void)
2	914.2	21.7 / Shale 24.0 / Shale 24.5 / Chert 33.0 / Shale 35.0 / Chert	2.3	50 50	21.8 to 24.0 (Clay Seam)
3	912.6	23.0 / Shale 28.0 / Limestone	9.8	100-100-100 100-72-40	-
4	917.2	23.5 / Limestone	10.0	100-97-100 32-78-44	-
5	914.9	6.0 / Shale	15.4	100-100-100-100 34-60-95-56	-
6	915.5	9.0 / Limestone 10.1 / Shale 12.5 / Limestone	16.8	77-100-97-100 44-93-95-92	-
7	917.4	23.5 / Chert	None	N/A	-
8	915.8	13.0 / Limestone 20.3 / Shale 27.0 / Chert	14.9	100-100-100-100 97-98-58-71	-
9	917.3	22.8 / Chert 25.4 / Limestone 29.7 / Chert	11.3	100-52-65 0-30-18	Below 34.1 (Clayey Gravel or Gravelly Clay)
10	917.5	19.0 / Chert	None	N/A	-
11	916.1	15.0 / Chert	None	N/A	-
12	918.0	18.0 / Chert	None	N/A	32.0 to 36.0 (Clam Seam)
13	919.5	23.5 / Shale 25.3 / Limestone	7.5	100-100-83 100-45-71	-
20	916.8	9.0 / Chert	None	N/A	Below 23.0 (Clayey Gravel)
21	916.5	None	None	N/A	-
22	919.4	30.0 / Chert	None	N/A	-
23	916.5	30.0 / Chert	None	N/A	-
24	917.4	None	None	N/A	-
25	920.4	30.0 / Chert	None	N/A	-
26	918.7	10.0 / Chert	None	N/A	-
27	920.1	15.0 / Chert	None	N/A	Below 23.0 (Clayey Gravel)

Boring	Surface El.	Approx. Depth to Top of Rock / Rock Type (ft.)	Rock Core Retrieved (ft.)	Recovery (%) RQD (%)	Clay Seams or Voids (ft.)
28	921.9	18.0 / Chert	None	N/A	Below 32.5 (Clayey Gravel)
29	916.8	None	None	N/A	-
30	916.0	11.5 / Chert	None	N/A	Below 18.5 (Clayey Gravel)
32	917.5	20.5 / Chert	None	N/A	-
33	917.1	16.0 / Chert	None	N/A	Below 24.0 (Clayey Gravel)

7.2 Groundwater

Shallow groundwater was not observed within the borings on the date drilled. It should be noted that water-based drilling fluid was used during field drilling. As a result, obtaining groundwater levels was not possible. Based upon previous borings drilled within the general site area, groundwater is not anticipated to be encountered. It should be noted that during wet periods, perched groundwater may be encountered at the limestone/shale/chert and overburden soil contact. Groundwater levels should be expected to fluctuate with changes in site grading, precipitation, and regional groundwater levels. Groundwater may be encountered at shallower depths during wetter periods.

8.0 EARTHWORK

As previously mentioned, a final grading plan has not been prepared for this site, however, based upon discussions with the Project Civil Engineer, approximately 2 to 6 ft. of fill is anticipated to be required within the Replacement Hospital footprint, while +/- 1 ft. of cut/fill is anticipated within the footprint of the parking garage. The finish floor elevation of the Replacement Hospital is anticipated to match that of the existing Outpatient Health Clinic at El. 919 ft. In addition, the lowest level of the parking garage is anticipated to be within +/- 1 ft. of existing grades.

The initial phase of site preparation should include the following:

- The initial phase of site preparation should include removal of all concrete paving and baserock, if present. In addition, clearing and grubbing of all vegetative matter and topsoil, if present, should be performed within non-paved areas. All vegetative matter, including trees/root bulbs and topsoil should be removed from areas scheduled to receive new fill and/or slab/pavement construction;

- Topsoil/vegetative matter stripping on the order of 4-inches or less should be anticipated in non-paved areas. Topsoil should either be hauled off-site or stockpiled for reuse in lawn and landscape areas only;

- Concrete and baserock removed during site stripping may be reused as controlled fill, if concrete material is reduced in size to conform with Section 8.1 below; and

- Areas scheduled to receive controlled fill should be proof-rolled and approved in accordance with the following section of this report.

After the initial phase is complete, it is recommended that all building, pavement and undercut bottoms be proof-rolled to assure a stable subgrade. Proof-rolling consists essentially of rolling the ground surface with a loaded tandem axle dump truck or similar heavy rubber-tired construction equipment and noting any areas which rut or deflect during rolling. All soft subgrade areas, if any, identified during proof-rolling should be undercut and replaced with compacted fill as outlined below. Proof-rolling, undercutting and replacement should be monitored by a representative of PPI. **The depth and areal extent of undercutting soft subgrade areas will be largely dependent upon the time of year and related soil moisture conditions. If construction is initiated during or immediately following wetter months, the requirement for undercutting soft surficial soils below planned cut depths should be anticipated and reflected in the contract documents, but anticipated to be minimal.**

After evaluation by proof-rolling and approval, the subgrade should be scarified to a depth of at least 8 inches, adjusted to within the optimum moisture content ranges

and compacted to specified density, provided below (See Section 8.3). Placement of controlled fill may then proceed.

8.1 Fill Material Types

Fill Type[1]	USCS Classification	Acceptable Location for Placement
On-Site Soils / Imported Fill	GC, SC, SW or GW	**Required** beneath building footprint **(below foundation elements)**, extending outside perimeter walls a horizontal distance equal to the height of fill embankment. Also acceptable for all other areas/elevations not requiring LVC material.
Low Volume Change (LVC) Engineered Fill[2]	CL, GC, or SC (LL < 50)	**Required** beneath slabs for a depth of 2 ft., CL materials should be placed **above foundation elements only**. May be used below foundations if classifying as a GC or SC only. Acceptable for all other areas/elevations outside the building footprint as well.
On-Site Natural Soils	CH	Should **not** be placed within the upper 2 ft. beneath foundations, floor slabs and pavements.

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris and contain maximum rock size of 12 inches, or the lift thickness, whichever is less. Frozen material should not be used and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to its use.
2. Low plasticity cohesive soil or granular soil having a liquid limit of less than 50%, contain at least 15% fines retained on the No. 200 sieve, and preapproved by the Geotechnical Engineer.

8.2 Acceptable LVC Material

LVC material is recommended below floor slabs, above footing bottom elevation. Potential sources of LVC material are as follows:

- Import from an off-site borrow area complying with Table 8.1; and
- On-site soils, classifying as CL, SC or GC may be segregated during footing or floor slab undercutting procedures or general earthwork procedures.

Most soil types present at the project site classify as LVC fill material. Topsoil strippings or material containing organics should not be used as LVC material.

8.3 Compaction Requirements

Item	Description
Subgrade Scarification Depth	At least 8 inches
Fill Lift Thickness	12-inches (loose) using the minimum compactor referenced below.
Compaction Requirements[1]	• **Building Area** – Below Foundation Bearing Elevation – Six (6) passes (3 each direction) minimum using a self-propelled vibratory compactor with a minimum drum diameter of 48-inches, or 100% Standard Proctor Density (ASTM D698), whichever is applicable; • **Building Area** – Above Foundation Bearing Elevation & Below Floor Slabs – Three (3) passes of the compactor referenced above, or 95% Standard Proctor Density (ASTM D698), whichever is applicable; • **Pavements, Sidewalks & Exterior Slabs** – Same as Building Area above foundations; and • **Non-Structural Areas** – 90% Standard Proctor Density (ASTM D698).
Moisture Content	± 2% optimum moisture for CL, SC, GC, GW & SW Soil Types; and 0 to 4% above optimum for CH Soil Types.
Field Density Testing Frequency	• Building Areas – One (1) test every 2500 sq. ft. per fill lift; • Pavement Areas – One (1) test every 5000 sq. ft. per fill lift; and • No less than three (3) tests per each fill lift.
1. We recommend that engineered fill (including scarified compacted subgrade) be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.	

8.4 Site Drainage

Discharge from roof downspouts should be collected and diverted well away from the building perimeter. Rapid, efficient runoff away from the building should also be provided. In addition, landscaping requiring frequent watering should be prohibited adjacent to building foundations.

8.5 Excavations

Based upon the subsurface conditions encountered during this investigation, the on-site soils typically classify as Type B in accordance with OSHA regulations. Temporary excavations in soils classifying as Type B with a total height of less than 20 ft. should be cut no steeper than 1H:1V in accordance with OSHA guidelines. **Confirmation of soil classification during construction, as well**

as construction safety (including shoring, if required), is the responsibility of the contractor.

8.6 Rippability

As mentioned throughout this report, the overburden soils at the project site primarily consist of very dense clayey gravels with chert cobbles and boulders with isolated areas consisting of clays with a reduced chert content. Significant difficulty was experienced when drilling the geotechnical borings within this chert laden material. Based upon this information, the overburden soils are anticipated to be rippable with dozers, but with difficulty. In addition, areas resistant to ripping consisting of large chert boulders, requiring other removal methods (pneumatic breakers or blasting, if allowed) should be anticipated. The Earthwork Contractor should review the attached boring logs when assessing excavation difficulty at this site. Mass grading at this site is anticipated to occur at a slower rate as compared to sites where overburden soils are primarily fine grained (silts and clays).

8.7 Expansive Soils

Due to the overburden soils primarily consisting of clayey gravels and gravelly clays, significant shrink/swell behavior is not anticipated. Additionally, swell testing performed on the fat clays at the subject site exhibited low swell potential. If relatively chert free fat clay zones are encountered at footing bottom and finish subgrade elevation, they should be undercut 2 ft., or to gravelly clays/clayey gravels, whichever is shallower, and replaced with LVC fill material. Although isolated zones of fat clays were encountered during drilling, they are not the primary material anticipated within footing, floor slab and pavement subgrades. In any event, soil subgrades should not be allowed to become frozen, dry and desiccate prior to concrete placement.

8.8 Utility Trenches

Existing utility trenches are present within the proposed building footprint. If not completely removed during site grading, existing utility trenches should be relocated, and new trenches should be sited outside of the proposed structure footprints. If

existing utility pipes cannot be removed, it is recommended that they be plugged with grout to reduce the potential for moisture migration into the soil subgrade, as well as future collapse.

New utility trenches servicing the new structures are anticipated to be required. These trenches are often times sources of moisture migration into the structure. A relatively impervious material (clay with little rock, etc.) should be placed within the utility trench, surrounding the utility immediately outside the structure to reduce the potential for moisture migration into the structure via utility trenches. The "trench plug" should extend out from the structure a minimum of 5 ft. horizontally, and be placed in a controlled manner in accordance with Section 8.3 above.

9.0 FOUNDATIONS

Due to the variability of the subsurface conditions across the subject site and variability in structure height and loading, PPI has provided the following summary table providing foundation options for each structure anticipated.

Anticipated Loading	Anticipated Structures	Suitable Foundations	Allowable Shallow Foundation Bearing Capacity (if selected)
Lightly to Moderately Loaded Structure	Central Energy Structure	• Shallow Foundations bearing on soils; • Drilled Piers bearing in soils/chert; or • Driven Piles bearing in soil/chert.	5,000 psf
Light to Heavily Loaded Structure	Hospital Building	• Shallow Foundations bearing on soils/chert or rock fill; • Drilled Piers bearing in soils/chert or bedrock; or • Driven Piles bearing in soil/chert or bedrock.	3,500 psf on Natural Soils & 5,000 psf on 5-ft. Geogrid Reinforced Rock Fill (min.)
Heavily Loaded Structure	Parking Garage	• Shallow Foundations bearing on soils/chert or rock fill; • Drilled Piers Bearing in soils/chert.	4,000 psf on Natural Soils & 5,000 psf on 5-ft. Geogrid Reinforced Rock Fill (min.)

Recommendations for both shallow foundations and deep foundations are provided in the following sections. Due to primarily dense/stiff consistency of the existing overburden soils, both foundation systems may be utilized for light and heavy

foundation loads. In order to increase the allowable bearing pressure for the hospital and/or parking garage foundations, existing soils may be undercut sufficient to provide a minimum 5 ft. depth below foundation bottom elevation and replaced with a compacted rock fill. Rock fill, if selected, should consist of 6-inch minus crushed limestone, or engineer approved equal, placed in lifts no greater than 1 ft. and compacted by a minimum of five (5) passes of a large, self-propelled vibratory compactor. A layer of Tensar TX-7 should be placed between the rock fill and overburden soils below the footprint of the proposed footing location, with the rock fill and geogrid extending a minimum of 5 ft. horizontally beyond footing perimeters.

Only one foundation type per structure is recommended to reduce the potential for differential settlement or structures designed to accommodate some differential settlement between foundation types.

9.1 Shallow Foundations

Foundation loads at this project site may be supported upon stiff or dense natural overburden soils or controlled fill placed in accordance with Section 8.0 of this report. Recommendations for shallow foundation design and construction are provided in the following tables. A separate table has been provided for each of the 3 structures anticipated at the site.

Shallow Foundations – Central Energy Center		
Description	**Mat or Spread Footing**	**Continuous Footing**
Net Allowable Bearing Pressure – Central Energy Structures ONLY[1]	5,000 psf	5,000 psf
Minimum Dimensions	2.5 ft.	1.5 ft.
Recommended Bearing Depth (Natural Soils or Controlled Fill)[2]	Depth sufficient to achieve minimum frost protection	
Minimum Embedment Below Finished Grade for Frost Protection & Variation in Soil Moisture[3]	2.0 ft.	
Allowable Passive Pressure[4]	230 pcf (equivalent fluid pressure)	
Coefficient of Sliding Friction[5]	0.50 (natural soils or controlled fill)	
Modulus of Subgrade Reaction[6]	175 pci	

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. The recommended pressure considers that all unsuitable and/or soft or loose soils, if encountered, are undercut and replaced with tested and approved new engineered fill. Footing excavations should be free of loose and disturbed material, debris, and water when concrete is placed.
2. PPI should be retaining to observe footing bottoms prior to placing concrete.
3. For perimeter footings and footings beneath unheated areas.
4. Allowable passive pressure value considers a Factor of Safety of about 2. Passive pressure value applies to undisturbed native clay or properly compacted fill. If formed footings are constructed, the space between the formed side of a footing and excavation sidewall should be cleaned of all loose material, debris, and water and backfilled with tested and approved fill compacted to at least 95% of the material's Standard Proctor dry density. Passive resistance should be neglected for the upper 2.5 ft. of the soil below the final adjacent grade due to strength loss from freeze/thaw and shrink/swell.
5. Coefficient of friction value is an allowable value assuming a Factor of Safety equal to approximately 2. This value is applicable for on-site clayey gravels and gravelly clays.
6. Foundation may be designed as a large mat footing due to the unknown exact location of the foundation loads in this area.

Shallow Foundations – Replacement Hospital		
Description	**Column (Spread Footing)**	**Continuous Footing**
Net Allowable Bearing Pressure – Replacement Hospital ONLY[1] *(Bearing in Existing Soils/Soil Fill)*	3,500 psf	3,000 psf
Net Allowable Bearing Pressure – Replacement Hospital[1] *(Bearing on 5 ft. Min. Geogrid Reinforced Rock Fill)*	5,000 psf	5,000 psf
Minimum Dimensions	2.5 ft.	1.5 ft.
Recommended Bearing Depth (Natural Soils or Controlled Fill)[2]	Depth sufficient to achieve minimum frost protection	
Minimum Embedment Below Finished Grade for Frost Protection & Variation in Soil Moisture[3]	2.0 ft.	
Allowable Passive Pressure[4]	230 pcf (equivalent fluid pressure)	
Coefficient of Sliding Friction[5]	0.50 (natural soils or controlled fill)	

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. The recommended pressure considers that all unsuitable and/or soft or loose soils, if encountered, are undercut and replaced with tested and approved new engineered fill. Footing excavations should be free of loose and disturbed material, debris, and water when concrete is placed.
2. PPI should be retaining to observe footing bottoms prior to placing concrete.
3. For perimeter footings and footings beneath unheated areas.
4. Allowable passive pressure value considers a Factor of Safety of about 2. Passive pressure value applies to undisturbed native clay or properly compacted fill. If formed footings are constructed, the space between the formed side of a footing and excavation sidewall should be cleaned of all loose material, debris, and water and backfilled with tested and approved fill compacted to at least 95% of the material's Standard Proctor dry density. Passive resistance should be neglected for the upper 2.5 ft. of the soil below the final adjacent grade due to strength loss from freeze/thaw and shrink/swell.
5. Coefficient of friction value is an allowable value assuming a Factor of Safety equal to approximately 2. This value is applicable for on-site clayey gravels and gravelly clays.

Shallow Foundations – Parking Garage		
Description	**Column (Spread Footing)**	**Continuous Footing**
Net Allowable Bearing Pressure – Parking Garage[1] *(Bearing in Existing Soils/Soil Fill)*	4,000 psf	4,000 psf
Net Allowable Bearing Pressure – Parking Garage[1] *(Bearing on 5 ft. Min. Geogrid Reinforced Rock Fill)*	5,000 psf	5,000 psf
Minimum Dimensions	2.5 ft.	1.5 ft.
Recommended Bearing Depth (Natural Soils or Controlled Fill)[2]	Depth sufficient to achieve minimum frost protection	
Minimum Embedment Below Finished Grade for Frost Protection & Variation in Soil Moisture[3]	2.0 ft.	
Allowable Passive Pressure[4]	230 pcf (equivalent fluid pressure)	
Coefficient of Sliding Friction[5]	0.50 (natural soils or controlled fill)	

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. The recommended pressure considers that all unsuitable and/or soft or loose soils, if encountered, are undercut and replaced with tested and approved new engineered fill. Footing excavations should be free of loose and disturbed material, debris, and water when concrete is placed.
2. PPI should be retaining to observe footing bottoms prior to placing concrete.
3. For perimeter footings and footings beneath unheated areas.
4. Allowable passive pressure value considers a Factor of Safety of about 2. Passive pressure value applies to undisturbed native clay or properly compacted fill. If formed footings are constructed, the space between the formed side of a footing and excavation sidewall should be cleaned of all loose material, debris, and water and backfilled with tested and approved fill compacted to at least 95% of the material's Standard Proctor dry density. Passive resistance should be neglected for the upper 2.5 ft. of the soil below the final adjacent grade due to strength loss from freeze/thaw and shrink/swell.
5. Coefficient of friction value is an allowable value assuming a Factor of Safety equal to approximately 2. This value is applicable for on-site clayey gravels and gravelly clays.

9.1.1 Uplift Capacity of Shallow Foundations

Resistance of shallow spread footings to uplift (Up) may be based upon the dead weight of the concrete footing structure (W_C) and the weight of soil backfill contained in an inverted cone or pyramid directly above the footings (W_S). The following parameters may be used in design:

Description	Weights
Weight of Concrete (W_c)	150 pcf
Weight of Soil Resistance (W_s)	100 pcf

The base of the cone or pyramid should be the top of the footing and the pyramid or cone sides should form an angle of 30 degrees with the vertical. Allowable

uplift capacity (U_p) should be computed as the lesser of the two (2) equations listed below:

$$U_P = (W_S/2.0) + (W_C/1.25) \text{ or } U_P = (W_S + W_C)/1.5$$

9.1.2 Construction Considerations for Shallow Foundations

It is essential that footing bottoms should not be allowed to become dry and desiccate prior to concrete placement to help reduce the potential for shrink/swell behavior. Footings should be clean and free of standing water, debris, and loose soil at the time of concrete placement. Footing/mat excavations should be observed by a representative of PPI prior to placement of reinforcing steel and concrete placement.

9.1.3 Ground Improvement

Due to the dense to very dense overburden soils at the project site, ground improvement using aggregate piers is not believed to be an economical foundation system, nor provide appreciable additional foundation capacity. Due to the significant drilling difficulties associated with very dense and large size chert, installation of aggregate piers is anticipated to be costly, as well as time consuming and provide little increase in allowable bearing capacity.

9.2 Deep Foundations

Deep foundations are also considered a viable foundation alternate. Several methods of deep foundation support were evaluated for this site. However, due to the varying site conditions across the 3 structure types, only two (2) deep foundation alternates have been recommended. The two (2) deep foundation system alternates include:

Drilled piers bearing in dense natural overburden soils/chert or limestone/shale bedrock; orpredrilled driven piling bearing in dense natural overburden soils/chert or limestone/shale bedrock.

9.2.1 Drilled Piers

As previously mentioned, subsurface explorations at the subject site encountered variable bearing materials. Soils noted in the north half **(Zone 1)** of the site generally consisted of shallow clays over chert gravels and boulders with variable amounts of clay and no indications of bedrock, i.e. limestone or shale. However, borings on the south half **(Zone 2)** of the subject site consisted of clay overburden with reduced amounts of gravel terminating on bedrock material. Rock coring was performed where encountered bedrock was suitable for coring procedures. Bedrock was noted in Borings 1, 2, 3, 4, 5, 6, 8, 9, and 13. Top of bedrock within these borings ranged from 6 ft. to 24 ft. below the ground surface and consisted of shale and argillaceous limestone and cherty areas noted. **Refer to Figure 2 where Zones 1 and 2 have been generally delineated.**

Due to the highly variable subsurface conditions at the subject site, as explained above, deep foundation recommendations have been provided for the 2 distinct subsurface conditions, which sometimes change within a building footprint. The Owner and Design Team should recognize that the recommendations provided in this section are subdivided into two (2) zones and these zones were selected based upon the widespread geotechnical borings drilled. As discussed throughout this report, highly variable subsurface conditions were found during field drilling. It is considered possible that during deep foundation installation, differing subsurface conditions may be encountered requiring redesign of certain drilled pier locations. It is difficult to determine areas that have higher potential than others, but the Owner and Design Team should recognize the possibility.

Based on PPI's past experience on projects near the subject site, the subsurface may contain isolated areas of small voids within the subsurface soils and bedrock. This condition was encountered in Borings 1 and 2 at depths of 21.8 to 21.9 ft. below the ground surface. If the bedrock embedment depths recommended below are achieved, drilled piers within this area should bear below the voids encountered in Borings 1 and 2. If additional voids are encountered during the drilled pier installation, drilled piers should extend

through the voids and bear a minimum of 1 foot into competent bedrock below the void.

9.2.2 Drilled Pier Design Recommendations

Description	Value	
Foundation Type	Straight shaft drilled piers.	
Bearing Material[1]	**Zone 1**	Dense to very dense natural clayey chert or very stiff cherty clay overburden soils.
	Zone 2	Competent limestone, shale or chert, which is anticipated in Borings 1-6, 8, 9 and 13.
Minimum Pier Penetration	**Zone 1**	Min. 25 ft. below existing ground surface or deeper **(do not stop in soft soils)**
	Zone 2	Min. 5 ft. rock socket into competent bedrock consisting of limestone, shale or solid chert.
Maximum Net Allowable Bearing Pressure[2]	**Zone 1**	20 ksf w/out proof testing. Much higher bearing pressures are possible at certain locations IF proof testing is performed.
	Zone 2	100 ksf w/ Proof Testing (50 ksf w/out)
Investigative Boring - Proof-Testing	**Zone 1**	See Section 9.2.3 for additional information if Net Allowable Bearing Pressure is desired to be increased.
	Zone 2	See Section 9.2.4 for additional information for proof-testing.
Maximum Allowable Skin Friction – Axial Compression[3]	**Zone 1**	0.75 ksf (clayey gravel/gravelly clay) – Full Pier Depth
	Zone 2	- Ignore Overburden Soils - 1.5 ksf (shale, limestone or solid chert)
Maximum Allowable Skin Friction – Uplift[4]	**Zone 1**	- 0.75 ksf (clayey gravel/gravelly clay) - Full Pier Depth
	Zone 2	- 0.5 ksf (overburden soils) - 1.5 ksf (shale, limestone or solid chert)
Group Effects – Axial Capacity	Piers should be installed with a center-to-center spacing of at least 2.5 pier diameters. Group effects can be neglected and the total capacity of the pier group taken as the sum of the individual per capacities, provided that the adjacent piers are spaced at least 2.5 pier diameters (center-to-center).	

Description	Value	
Group Effects – Lateral Capacity	When piers are installed close together, the lateral capacity of the group is not equivalent to the lateral capacity of an isolated individual pier times the number of piers in the group. Only those piers that are unobstructed by the other piers in the direction of the force develop full capacity. For pier groups with a pier spacing of 2.5 pier diameters center-to-center, a multiplier of 0.8 should be used for the lead row of piers, 0.4 for the 2nd row and 0.3 for the 3rd and subsequent rows. The efficiency of the pier group is dependent upon the pier layout in the group, but would typically be on the order of 75 percent of a single pier for a pier spacing of 2.5 pier diameters. The pier group effect increases significantly for closer spacing, resulting in lower efficiency.	
Minimum Shaft Diameter[5]	30-inches	
Minimum Grade Beam Bearing Depth	24-inches below final exterior adjacent grade	
Estimated Total Settlement	**Zone 1**	0.5-inches or less
	Zone 2	Negligible
Estimated Differential Settlement	**Zone 1**	0.25-inch or less
	Zone 2	Negligible

1. Due to variations in the depth and quality of the dense to very dense overburden soils across the site, the Geotechnical Engineer or his representative should be present during pier drilling to verify that unsuitable bearing strata is not present within the pier bottom.
2. This is the pressure at the base of the foundation in excess of the adjacent overburden pressure. The allowable bearing pressure has a Factor of Safety of approximately 3.
3. The allowable skin friction has a Factor of Safety of approximately 2.
4. The allowable skin friction values have a Factor of Safety of approximately 2.
5. Sufficient steel reinforcement should be placed to provide adequate structural integrity.

9.2.3 Investigative Boring – Zone 1

Due to the varying subsurface conditions and the planned heavy foundation loads for these structures, to possibly increase pier allowable end bearing pressures and possibly eliminate or reduce the need for deep foundation groups and large pile caps, the Owner and Design Team may desire to perform pier pre-drilling. By pre-drilling a specific column/pier location, this will allow PPI to determine precise in-situ conditions at each location and allow specific testing to be performed at that location typically resulting in a decrease in drilled pier construction cost. Pre-drilling is often completed by augering to bedrock and coring several feet of the underlying bedrock to determine if clay seams and/or voids are present. However, due to the varying geology and soil conditions present at this site, the overburden soils will be required to be sampled for

strength characteristics, as well as rock coring if bedrock is encountered. If investigative coreholes are desired, PPI would be happy to coordinate with the project Structural Engineer to determine specific column loads and target borehole depths.

9.2.4 Proof-testing – Zone 2

The allowable end bearing pressure provided in the table in Section 9.2.2 is considered a higher end bearing pressure for limestone/shale/chert bedrock and will require additional field inspection during or before drilled pier installation to determine if voids or soft clay seams are located immediately below the pier bottom. In order for designers to use the allowable end bearing provided, each drilled pier bottom should be evaluated by a 2-inch diameter probe hole being drilling in the bottom of the pier to a depth of 1.5 times the pier diameter or 5 ft, whichever is deeper and scratch tested by a representative of PPI. In the event clay seams or voids are detected in the probe hole, the pier bottom should be deepened below the discontinuity and reevaluated by another probe hole. Recommended clay seam/void criteria is as follows:

- No clay seams or voids in the upper 3 ft.;
- No individual seam or void greater than ¼ inch in the next 3 ft.; and
- Total accumulation of clay seam or voids should not exceed ½ inch.

A second alternative to evaluating each drilled shaft is pre-drilling using NQ tooling. Prior to construction and once plan pier bottom elevation is determined, a geotechnical rig drills a 2-inch diameter test hole 10 ft below planned pier bottom elevation. The rock core is logged by an Engineer or Geologist to confirm design parameters, as well as set revised pier bottom elevation based upon discontinuities, if any, encountered in the test hole. PPI has performed pre-drilling on several hospital projects where higher end bearing pressures are desired, as well as construction schedules are accelerated. PPI can perform these services for this project, if desired.

9.2.5 Lateral Loading for Drilled Piers

It is anticipated that resistance of the foundations to lateral loading and the associated lateral deflection will be evaluated using finite difference computer models based on the horizontal modulus of subgrade reaction (K_h). The following values may be used in the analysis for this site.

Please note that the table states to ignore lateral support for the depth of 0 to 1 pier diameter or 2.5 ft., whichever is shallower. This notation is intended to account for the fact that near surface soils are significantly disturbed during drilled shaft excavation, which generally reduces the lateral support provided. Designers should use their judgment and make an appropriate reduction of soil strength parameters in this zone.

Values summarized in the table below are based upon published correlations and field and laboratory data collected during this subsurface investigation. **Values shown below are ultimate values representative of in-situ soil properties, and do not include a Factor of Safety.** These values may be used to compute resistance to lateral loading of the overburden soils. The appropriate Factor of Safety should be chosen by the designer.

Deep Foundations – Lateral Loading – Zone 1						
Stratum (Soil Type)	**Applicable Depth (ft.)**	**Unit Weight (pcf)**	**Cohesion (psf)**	**Static K_h (pci)**	**Cyclic K_h (pci)**	**e_{50}**
Gravelly Clay / Clayey Gravel (Stiff Clay w/out Free Water)	*Ground Surface to 1 Pier Diameter	Ignore	Ignore	-	-	-
Gravelly Clay / Clayey Gravel (Stiff Clay w/out Free Water)	*1 Pier Diameter to Bottom of Pier	125	2,000	1000	400	0.005
*Lateral parameters for the upper 1 pier diameter, or 2.5 ft., whichever is shallower, should be ignored.						

Deep Foundations – Lateral Loading – Zone 2						
Stratum (Soil Type)	**Applicable Depth (ft.)**	**Unit Weight (pcf)**	**Cohesion (psf)**	**Static K_h (pci)**	**Cyclic K_h (pci)**	**e_{50}**
Gravelly Clay / Clayey Gravel (Stiff Clay w/out Free Water)	*0-1 Pier Diameter	Ignore	Ignore	-	-	-
Gravelly Clay / Clayey Gravel (Stiff Clay w/out Free Water)	*1 Pier Diameter to Top of Bedrock	125	2,000	1000	400	0.005
Limestone / Shale / Chert (Strong Rock)	Top of Bedrock to Bottom of Pier	140	**Unconfined Compressive Strength (psi)** 4,000	-	-	-
*Lateral parameters for the upper 1 pier diameter, or 2.5 ft., whichever is shallower, should be ignored.						

The above values were measured or based upon published correlations with anticipated soil strength and classification tests.

9.2.6 Drilled Pier Construction Recommendations

Drilled piers bearing in soil should have a straight shaft and should be founded at the depths recommended above. **Overburden soils/chert and limestone are considered very resistant to typical auger methods. In any event, the drilled pier contractor should anticipate the use of rock augers, rock core barrels and potentially down the hole hammers with a heavy-duty drill rig in order to excavate the drilled piers to the minimum depths specified.**

Based upon the results of this investigation, the drilled pier contractor should be prepared to mobilize casing due to potential caving gravel and boulder sidewalls, although most piers are not anticipated to require temporary casing. Casing may be extracted as the shaft concrete is placed, if required. Drilled pier bottoms should be well cleaned of all loose soil and rock fragments at the time of concrete placement. No more than 2 to 3 inches of water should be present in the bottom of piers when concrete is introduced into the shaft. **The drilled pier contractor**

should also anticipate minor to moderate concrete loss in small voids/cracks within the boulders and cobbles within the overburden soils. Concrete over-run related to sloughing or caving of the shaft sidewalls is possible and unit prices should be established for these items in the contract documents, if required.

9.2.7 Drilled Pier Load Test

An on-site load test of a production drilled pier is not considered a requirement. Isolated piers or pier groups may encounter differing conditions as compared to this report. It is recommended that the contractor bid form include a cost to perform such a load test in the event differing subsurface conditions are encountered during drilled pier installation. Pier load tests, if required, should be performed in accordance with ASTM D1143 and ASTM D3689 for compressive and tensile capacity.

9.2.8 Concrete Loss Due to Voids

Although not anticipated to be significant, concrete volume loss during drilled pier construction is possible. Some small voids were identified during this investigation and have been identified at this site. Some concrete loss during drilled pier installation should be anticipated and included in contract documents. If large voids are encountered, PPI should be contacted for additional consultation.

9.3 Driven Piles

Another deep foundation alternate considered applicable at the project site is driven piling. Design recommendations for driven H-Piles are presented in the table below.

Deep Foundations – Driven Piles – Zones 1 & 2	
Description	**Value**
Foundation Type[1]	Steel H Piles w/End Protection.
Bearing Material	Dense to very dense or stiff natural overburden soils/chert. If bedrock is encountered, driven piles may bear on competent bedrock materials.
Minimum Pile Penetration[2]	25 ft. below existing ground surface or to the depth of competent bedrock.
Allowable Pile Capacity – Axial Compression	If driven to practical refusal, the allowable stress of the pile cross section controls the pile capacity. Compressive stress developed in the steel section should not exceed 9 kips per square inch (ksi) for 36 ksi grade steel and 12.5 ksi for 50 ksi grade steel sections.
Allowable Skin Friction – Uplift[3]	0.4 ksf (overburden soils/backfill)
Group Effects – Axial Capacity	Driven piles should be installed with a center-to-center spacing of at least three (3) pile widths. Group effects can be neglected and the total capacity of the pile group taken as the sum of the individual pile capacities provided that adjacent piles are spaced at least three (3) pile widths (center-to-center). Design of the piling as structural members should be in accordance with applicable building codes.
Group Effects – Lateral Capacity	When piles are installed close together, the lateral capacity of the group is not equivalent to the lateral capacity of an isolated individual pile times the number of piles in that group. Only those piles that are unobstructed by the other piles in the direction of the force develop full capacity. For pile groups with a pile spacing of three (3) pile widths center-to-center, a multiplier of 0.8 should be used for the lead row of piles, 0.4 for the 2nd row, and 0.3 for the 3rd and consecutive rows. The efficiency of the pile group is dependent upon the pile layout in the group, but would typically be on the order of 75 percent of a single pile for a pile spacing of three (3) pile widths. The pile group effect increases significantly for closer spacing, resulting in a lower efficiency.
Minimum Pile Cap & Grade Beam Bearing	24-inches below final exterior adjacent grade.

Deep Foundations – Driven Piles – Zones 1 & 2	
Description	**Value**
Estimated Total Settlement	- Negligible (Bedrock) - 0.5-inch or less (Clayey Gravels)
Estimated Differential Settlement	0.25-inch or less (Clayey Gravels)

1. Because of the relatively high driving resistance expected from the overburden soils/chert, steel H-piles with end protection are recommended so that the anticipated high driving stresses can be endured. Driven piles will develop their capacity from end bearing and side resistance in the very dense overburden soils below the pre-bore depth.
2. The pile should be driven to practical refusal, which should occur after penetrations of 1 to several feet into very dense overburden soils. We recommend that the pile installation be monitored by a representative of PPI.
3. The allowable skin friction has a Factor of Safety of approximately 2 and applies to the non-pre-bored depth only. Skin friction within the pre-bore depth should be ignored.

9.3.1 H-Pile Driving Criteria & Pre-Boring

Specifications for end bearing H-Piles should clearly state that end-bearing piles should be driven to refusal. Prior to driving structural steel piles, the contractor should review the boring logs to determine the depth at which impenetrable overburden soils may be anticipated. In addition, the contractor should submit a hammer wave equation to be evaluated and used during PDA testing (see below). The contractor should be attentive to the physical conditions associated with pile refusal. Pile refusal should be determined by on-site PDA testing. Pile refusal depth is anticipated to be highly variable. Pile refusal is anticipated to occur within approximately 5 ft. or less below the prebore depth due to very dense gravels encountered within the borings.

As stated above, pile driving refusal should be defined during PDA testing with an approved hammer. An approved hammer shall be defined as a hammer that develops the minimum hammer energy that is no less than any of the following:

1. 3.0 ft-lb/lb times the total pile weight in pounds, including mandrel, if used;
2. 32 ft-lb/kip times the minimum nominal axial compressive resistance in kips, divided by the pile batter factor, β, if applicable; and
3. 8,000 ft-lb.

In order to achieve full pile development and to ensure the pile reaches the intended very dense bearing stratum, pre-boring pile locations to a minimum

depth of 25 ft. minimum is recommended; however, if competent bedrock is encountered within the pre-boring, the pile may be shortened to bear in the competent bedrock material. The pre-bored hole may be filled with sand prior to or following pile driving.

As discussed in Section 9.2.1, possible voids were noted in Borings 1 and 2 within the bedrock. It is recommended that pre-boring for driven piles be extended a minimum of 25 ft. in this area to identify the presence of possible voids to limit bearing failures of driven piles.

9.3.2 Driven Pile Construction Observation & PDA Testing

Construction surveillance activities should be provided throughout pile installation. Specific information regarding pile driving should be maintained in daily log form. The daily log form should include hammer type, energy, operating characteristics, driving time, delays, and other pertinent information. Complete pile driving records should be kept for the Project. Care should be exercised to monitor pile hammer operation to verify actual hammer energy.

In addition, PDA Testing (or dynamic load testing using a Pile Driving Analyzer) is recommended to confirm that damage to the pile has not occurred during driving, **and that the pile will carry the design load**. It is possible for piles to be driven down the side of a large chert boulder, resulting in pile deflection and subsequent damage. PDA testing would be especially useful in this case. A minimum of five (5) PDA tests or piles within a footprint of 50,000 sq. ft. is recommended spread over the structure footprint prior to production pile installation. A firm that has significant experience in PDA testing and that PPI has significant work experience with is listed below for your use, if desired.

Foundation Testing & Consulting, LLC
Mr. Casey Jones, P.E., P.G. – Technical Director
16500 Lucille Street
Overland Park, Kansas 66062
Ph: 913-626-8499

Email: cj@FTandC.com

9.3.3 Lateral Loadings for Driven Piles

The lateral loading parameters provided in Section 9.2.3 above may be used during foundation design utilizing driven piling.

9.4 Settlement Potential

Due to the overburden soils primarily consisting of dense to very dense chert sands, gravels, and occasional gravelly clays, settlement potential of the natural overburden soils is anticipated to be minimal. To essentially eliminate the potential for foundation settlement, foundations should bear in bedrock. However, due to the sometimes deep depth of limestone bedrock anticipated at this site, bearing upon bedrock is not considered practical for all structures and areas of the site. If shallow foundations are constructed using the above foundation design parameters provided, total settlements on the order of 1-inch or less and differential settlements on the order of 0.5-inches or less are anticipated. If deep foundations are constructed using the above foundation design parameters provided, total settlements on the order of 0.5-inch or less and differential settlements on the order of 0.25-inches or less are anticipated.

10.0 SEISMIC CONSIDERATIONS

Code Used	Site Classification
2018 International Building Code (IBC)[1]	C[2]
1. In general accordance with the *2018 International Building Code*, Section 1613 2. Based upon an average Shear Wave Velocity of 2,170 feet per second within the top 100 ft. of depth computed during site shear wave velocity testing performed on 11/22/21 by PPI.	

According to the 2018 IBC, the Mapped Spectral Response Acceleration parameters for short period (F_a) and the 1-second period (F_v) for the project site are presented below.

Mapped Spectral Response Parameter	F_a	F_v
Value	1.2	1.7
Values are based upon a Site Class C, S_s = 15.3%, S_1 = 8.1% using Tables 11.4 (1 & 2) from ASCE 7-10		

The seismic site classification presented above was determined using shear wave velocity testing. Shear wave velocity testing was performed along one (1) array, or line, situated within the southeast corner of the proposed building footprint. Shear wave velocity testing was performed in substantial conformance with industry standards using surface seismic methods, more specifically Multi-Channel Analysis of Surface Waves (MASW).

Surface waves are a type of seismic wave whose propagation is confined to the near surface medium. The depth of subsurface penetration of a surface wave is directly proportional to its wavelength. In a non-homogeneous medium, surface waves are dispersive, meaning each wavelength has a characteristic velocity resulting from subsurface heterogeneities.

MASW Combined Active and Passive method was utilized to obtain the average shear wave velocity for the top 100 ft. (Vs 100) at the project site. This method was selected to increase the range of frequency to be analyzed therefore increasing the depth of investigation. Active method captures a dispersion curve at relatively higher frequencies than the Passive method. Combing the dispersion curves for each method allows for a more reliable identification of the fundamental mode dispersion curve utilized in calculating the shear wave velocity. Please refer to Figure 3 for the graphical shear wave velocity vs. depth output.

11.0 FLOOR SLABS

A slab-on-grade or slab-on-fill floor system is considered appropriate at the site based upon subsurface conditions encountered and future site grading. Listed below are key considerations for design purposes of the floor slab.

- Prior to placement of controlled fill, if any, natural soils should be scarified, moisture content adjusted and re-compacted in accordance with Sections 8.0 of this report;
- Fat clays containing little to no sand/gravel content present at slab subgrade elevation, if present, should be undercut and replaced in accordance with Section 8.7 above; and
- Prior to slab placement, soil moisture should be adjusted and maintained within the parameters specified in Section 8.0 of this report.

Placement of 4 or more inches of compacted free-draining granular base course below slabs that are not below grade is recommended to limit moisture rise through slabs and to improve slab support, particularly at joints. An impervious moisture barrier consisting of 6-mil plastic sheeting or equivalent should be provided in accordance with the 2012 IBC. Use of a 10-mil vapor barrier is recommended below all slab areas with an intended use sensitive to slab moisture.

11.1 Modulus of Subgrade Reaction

The floor slab by be designed with the modulus of subgrade reaction presented in the table below.

Bearing Material	Bearing Material Thickness (inches)	Modulus of Subgrade Reaction (pci)
LVC Fill Material and Natural Soils	N/A	175
Dense Graded Aggregate Base	6	275
Dense Graded Aggregate Base	12	350
Dense Graded Aggregate Base	18	425

12.0 BELOW GRADE SLABS

All slabs that are below exterior grade are considered below grade slabs. **The ground floor slab set at Elevation 919.0 is not considered a below grade slab, based upon the project grading plan. However, any elevator pits, recessed mats, floor depressions, etc., are considered below grade slabs and the following recommendations do apply to these areas.**

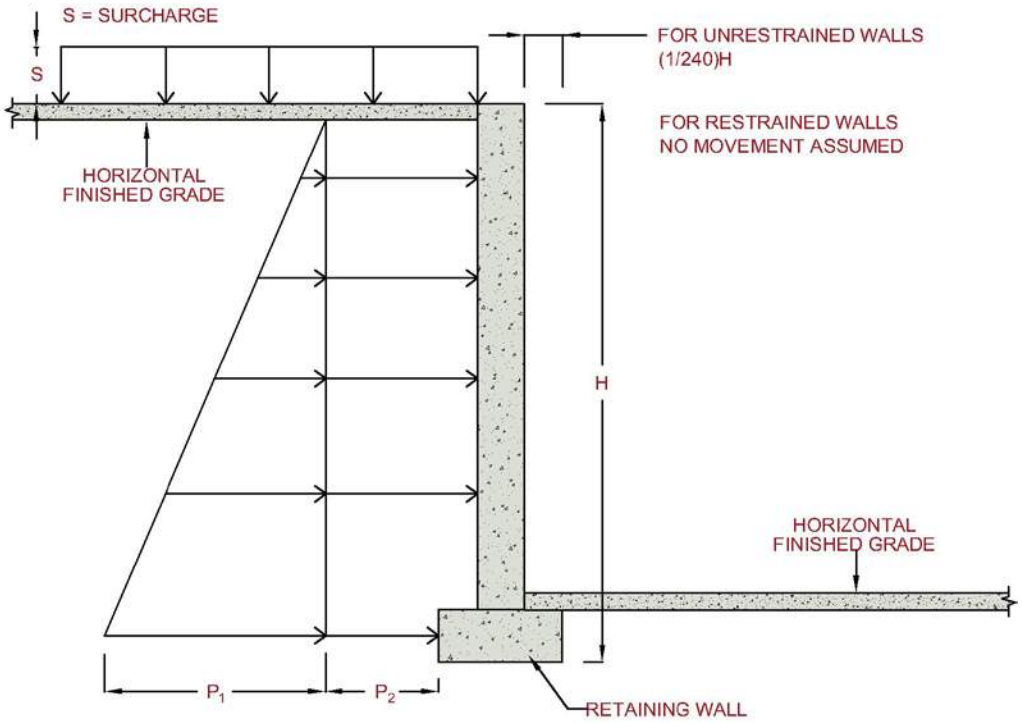
Although shallow groundwater was not encountered within the borings drilled, site earthwork can, and often does, manipulate the shallow groundwater regime. In view of the possibility for perched groundwater at the project site, it is recommended that any portions of the structure below exterior grade, as described above, be designed and constructed recognizing the possibility of shallow groundwater. A French drain system should be installed under the below grade floor slabs to limit hydrostatic pressure below the slab. A drainage system constructed with coarse free-draining gravel with a minimum 6-inch thickness and perforated pipes wrapped in filter fabric and installed on 30-ft. centers below the free draining gravel is considered adequate. Groundwater collected by these perforated pipe drains should be removed to free discharge by gravity flow. If gravity flow cannot be provided a sump and pump system consisting of a wet well with a duplex pump arrangement is recommended. At least one (1) pump should turn on when groundwater levels are more than 24-inches below finish floor elevation.

A French drain should be installed underneath all below grade slabs. Lateral drain pipes installed on 30-ft. centers should be at least 4-inches in diameter, with perimeter collector pipes at least 6-inches in diameter. An impervious moisture barrier consisting of 6-mil. plastic sheeting or equivalent should be provided below all slab areas. A minimum 10-mil plastic sheeting is recommended beneath all slab areas with an intended use sensitive to slab moisture. Soil moisture should not be allowed to dry and desiccate or be saturated by inundation prior to slab placement.

12.1 Retaining Wall Backfill & Drainage

A foundation drain is recommended to be installed around the portion of the perimeter where the below grade slab is at or below exterior grade level in accordance with the 2018 IBC. Below grade wall backfill should consist of free-draining crushed stone or alternatively, may consist of lean clay. Crushed stone, if selected, must be imported from a quarry source whereas on-site soils suitable for wall backfill could probably be segregated and stockpiled during excavation. Depending upon the type of backfill selected and degree of wall restraint, the following table of lateral earth pressures are considered appropriate for wall design.

If a building floor slab is planned over the wall backfill, use of an imported free draining stone should be separated from the earth face of the excavation by using a nonwoven filter fabric.



EQUIVALENT FLUID PRESSURES, P_1 (Drained Backfill Only)				
Type of Backfill	**Level Backfill**		**Sloped Backfill (2H:1V)***	
	Restrained Walls (Using K_o)	**Unrestrained Walls (Using K_a)**	**Restrained Walls (Using K_o)**	**Unrestrained Walls (Using K_a)**
Compacted On-Site GC, GW, SC & CL Soils	70 pcf	45 pcf	80 pcf	55 pcf
Clean Crushed Stone	50 pcf	35 pcf	60 pcf	45 pcf
Rock Fill (Free-Draining)	50 pcf	35 pcf	60 pcf	45 pcf
*For backfill sloped other than 2H:1V, interpolate between values presented above for level and sloped backfill. NOTE: Structural design of unrestrained walls should permit wall rotation at top of wall equal to 1/240th of wall height.				

SURCHARGE PRESSURE, P_2		
Type of Backfill	Level Backfill	
	Restrained Walls (Using K_o)	Unrestrained Walls (Using K_a)
Compacted On-Site GC, GW, SC & CL Soils	0.58 (S)	0.38 (S)
Clean Crushed Stone	0.42 (S)	0.29 (S)
Rock Fill (Free-Draining)	0.42 (S)	0.29 (S)

If crushed stone backfill is selected and wall design in accordance with the above equivalent fluid pressures, the crushed stone backfill should be placed within a boundary projecting 30 degrees from the vertical commencing at a point 1 ft. out from the base of wall. Regardless of the backfill type selected; an impervious moisture barrier should be applied to the below grade wall. In addition, if lean clay backfill is selected, a geosynthetic drainage mat should be applied to the wall to assure removal of subsurface water. A perforated pipe should be laid at the base of wall to collect and remove subsurface water either from free-draining crushed stone or drainage mats. Flow line of the perforated pipe should be laid below partial basement finished floor. Again, groundwater collected should be removed by gravity flow to free discharge. If this is not possible, groundwater may be removed by pumping. An exterior sump pit with dual pumping arrangement is recommended.

Please refer to Section 9.1 above for retaining wall foundation design parameters constructed in natural overburden soils or controlled fill material placed in accordance with Section 8.0 of this report. These parameters apply to below grade foundation walls and site retaining walls.

13.0 PAVEMENT

It is anticipated that any new pavements associated with this project will be constructed of either an asphaltic concrete wearing surface placed over a base or a rigid Portland Cement Concrete pavement over a granular base. Prior to pavement placement,

preparation of the pavement subgrade should be performed in accordance with Section 8.0 of this report.

13.1 Flexible Pavement

If asphaltic paving is selected, the aggregate base may be a granular compacted crushed limestone with a gradation and quality conforming to the requirements of the Oklahoma Department of Transportation (ODOT), Standard Specification 703.01 for Type A aggregate. The maximum lift thickness for the granular base is 4 in. Granular base thicknesses in excess of 4 inches should be placed in multiple lifts with each lift being of approximately equal thickness. The granular base should be compacted to at least 100% of Standard Proctor Compaction (ASTM D-698).

Asphaltic concrete, both base and surface, should conform to the applicable requirements of ODOT Standard Specification 708. Asphaltic concrete should be compacted to 92 to 96% of Maximum Theoretical Specific Gravity (ASTM D-2041). Substitution of an appropriate Superpave Mix Design, SP 190C or SP 250C, can be used in place of the bituminous base. SP 190C or SP 125C may be used for the surface. All bituminous mix designs should have been prepared or verified within 6 months of the date of placement on the project.

13.2 Rigid Pavement

If rigid concrete paving is selected, a minimum 4-in. thickness granular base compacted to 100% of Standard Proctor should be placed on the prepared subgrade. The Portland Cement Concrete (PCC) mix should have a minimum 28-day compressive strength of 4000 pounds per square inch (psi). Concrete should be placed at a low slump (1 to 3 inches) and have an entrained air content of 5 to 7%. If an increased slump is desired, use of Super Plasticizer is recommended.

13.3 Pavement Subgrade CBR

Based upon relatively high SPT-N values obtained during drilling, the natural soil deposits should exhibit stiff to hard subgrades for pavement construction. A CBR

value equal to 6.0 for the natural subgrade soils, or natural overburden soils that have been properly recompacted is recommended to be used in pavement design.

13.4 Pavement Thickness

Typical pavement design for this type of development would generally generate a Structural Number of 3.0 to 3.5 within heavy duty areas and 2.4 to 2.6 within light duty areas, depending on the subgrade conditions. The following table presents corresponding typical flexible and rigid pavement thickness using the general Structural Numbers.

Pavement Type	Anticipated Traffic Frequency	Asphaltic Surface (in.)	Asphaltic Base (in.)	Concrete Thickness (in.)	Aggregate Base (in.)
Flexible Pavement	Heavy Duty	3.0	4.0	-	6.0
	Medium Duty	2.0	3.0	-	6.0
	Light Duty	2.0	2.0	-	6.0
Rigid Pavement	Heavy Duty	-	-	7.0	4.0
	Medium Duty	-	-	6.0	4.0
	Light Duty	-	-	5.0	4.0

14.0 CONSTRUCTION OBSERVATION & TESTING

The construction process is an integral design component with respect to the geotechnical aspects of a project. Since geotechnical engineering is influenced by variable depositional and weathering processes and because we sample only a small portion of the soils affecting the performance of the proposed structures, unanticipated or changed conditions can be disclosed during grading. Proper geotechnical observation and testing during construction is imperative to allow the Geotechnical Engineer the opportunity to evaluate assumptions made during the design process. Therefore, we recommend that PPI be kept apprised of design modifications and construction schedule of the proposed project to observe compliance with the design concepts and geotechnical recommendations, and to allow design changes in the event that subsurface conditions or methods of construction differ from those assumed while completing this study. We recommend that during construction all earthwork be

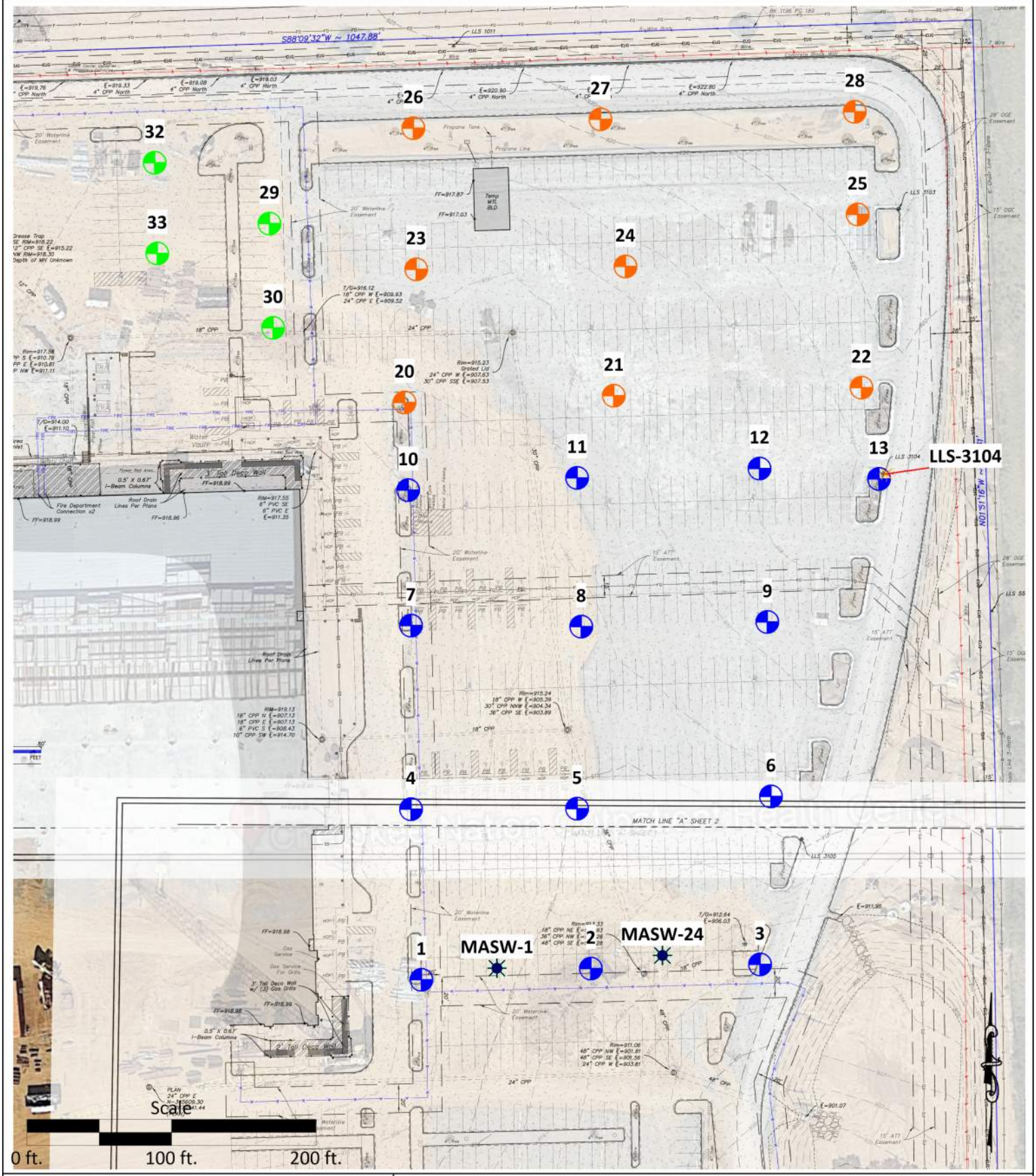
monitored by a representative of PPI, including site preparation, placement of all engineered fill and trench backfill, and all foundation excavations as outlined below.

- An experienced Geotechnical Engineer or Engineering Technician of PPI should observe the subgrade throughout the proposed project site immediately following stripping to evaluate the native clay, identify areas requiring additional undercutting, and evaluate the suitability of the exposed surface for fill placement;
- An experienced Engineering Technician of PPI should monitor and test all fill placed within the building and pavement areas to determine whether the type of material, moisture content, and degree of compaction are within recommended limits. **Refer to Section 8.3 for recommendations regarding Field Density (compaction) testing frequency**;
- An experienced Technician or Engineer of PPI should observe and test all footing excavations. Where unsuitable bearing conditions are observed, remedial procedures can be established in the field to avoid construction delays; and
- The condition of the subgrade should be evaluated immediately prior to construction of the building floor slabs to determine whether the moisture content and relative density of the subgrade soils are as recommended.

15.0 REPORT LIMITATIONS

This report has been prepared in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area. Palmerton & Parrish, Inc. observed that degree of care and skill generally exercised by other consultants under similar circumstances and conditions. Palmerton & Parrish's findings and conclusions must be considered not as scientific certainties, but as opinions based on our professional judgment concerning the significance of the data gathered during the course of this investigation. Other than this, no warranty is implied or intended.

FIGURES



LEGEND

- Building Boring Location
- Parking Boring Location
- Equipment Boring Location
- MASW Testing Ends
- Referenced Benchmark

Aerial Image From Google Earth Pro
Drawings Provided By Client

Project: W.W. Hastings Replacement Hospital and Parking Garage
Client: Childers Architect

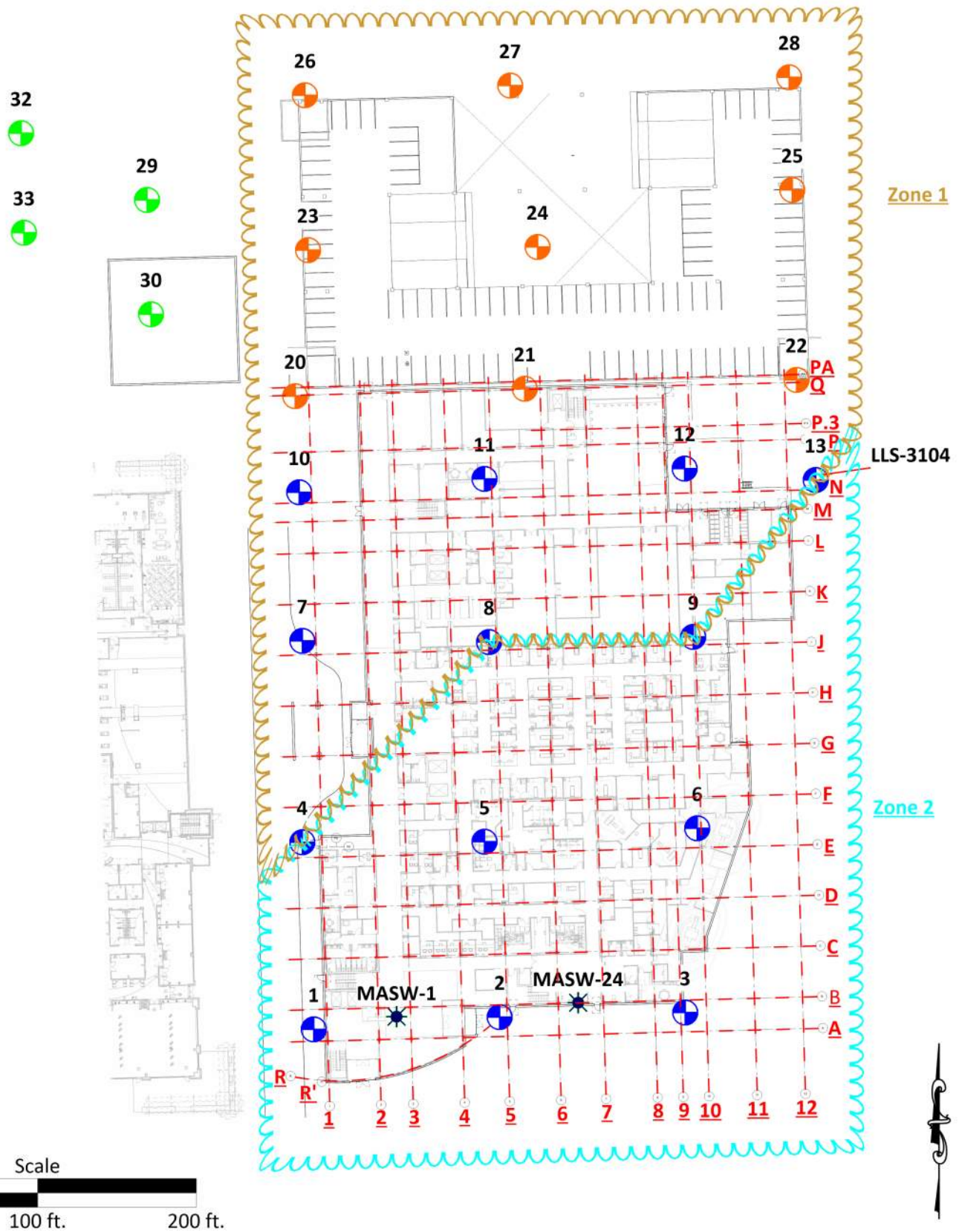
Boring & MASW Location Plan

DATE: January 26, 2022

Project Number: 277340

PALMERTON & PARRISH, INC.
GEOTECHNICAL AND MATERIALS ENGINEERS/MATERIALS TESTING LABORATORIES/ENVIRONMENTAL SERVICES

FIGURE 1



LEGEND

- Building Boring Location
- Parking Boring Location
- Equipment Boring Location
- MASW Testing Ends
- Referenced Benchmark

Aerial Image From Google Earth Pro
Drawings Provided By Client

Project: W.W. Hastings Replacement Hospital and Parking Garage
Client: Childers Architect

Boring & Subsurface Zone Plan

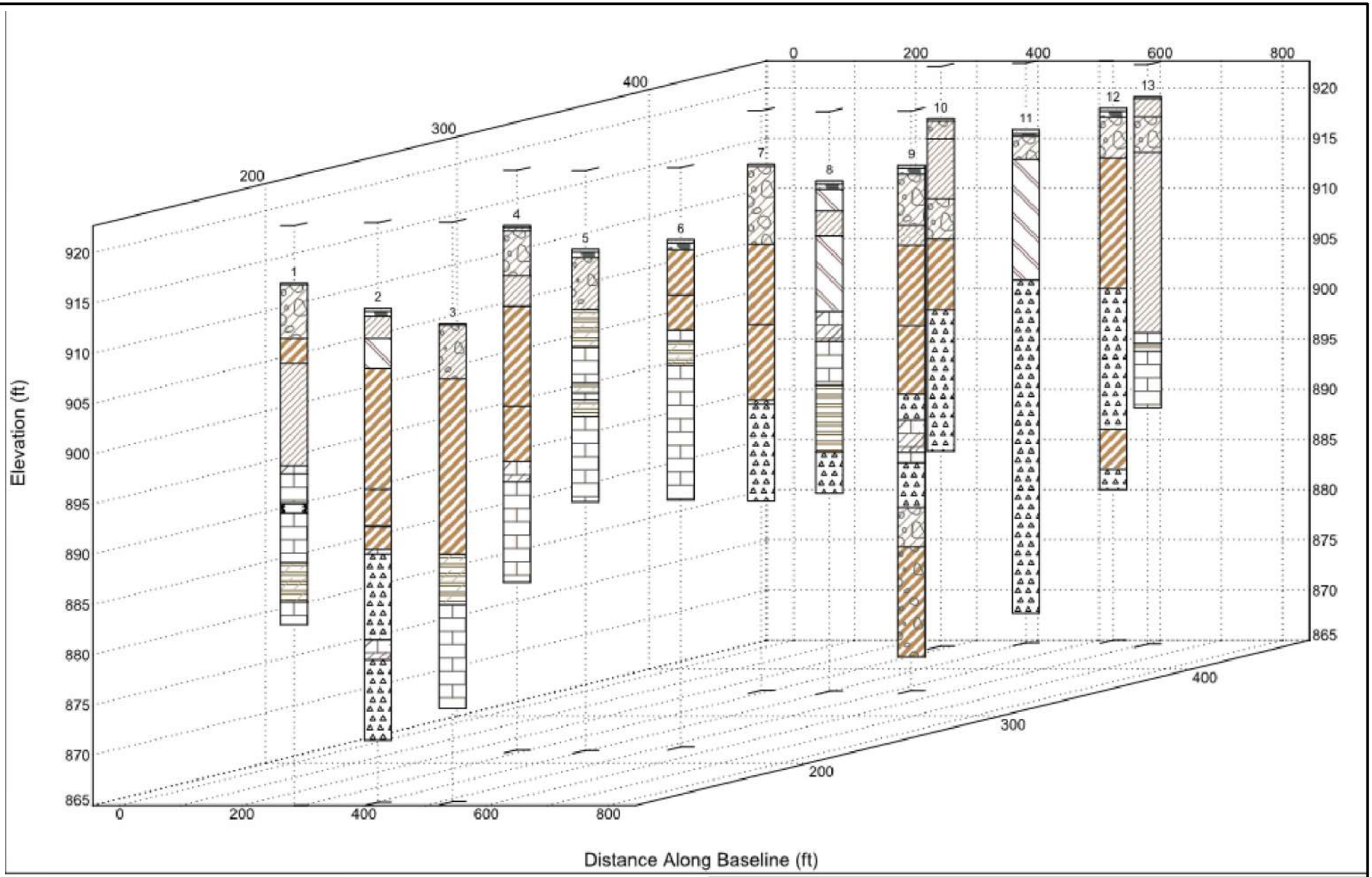
DATE: January 26, 2022

Project Number: 277340

PALMERTON & PARRISH, INC.
GEOTECHNICAL AND MATERIALS ENGINEERS/MATERIALS TESTING LABORATORIES/ENVIRONMENTAL SERVICES

FIGURE 2

S:_MASTER PROJECT FILE\2021\OK\C\Childers Architect-277340-WW Hastings Replacement Hospital-Sub\Figures\MASW Output



NOTES

- Buildings Borings Only
- Viewing Angles
  - Horizontal:70 deg.
  - Vertical: 20 deg.

Project: W.W. Hastings Hospital Replacement and Parking Garage
Client: Childers Architect

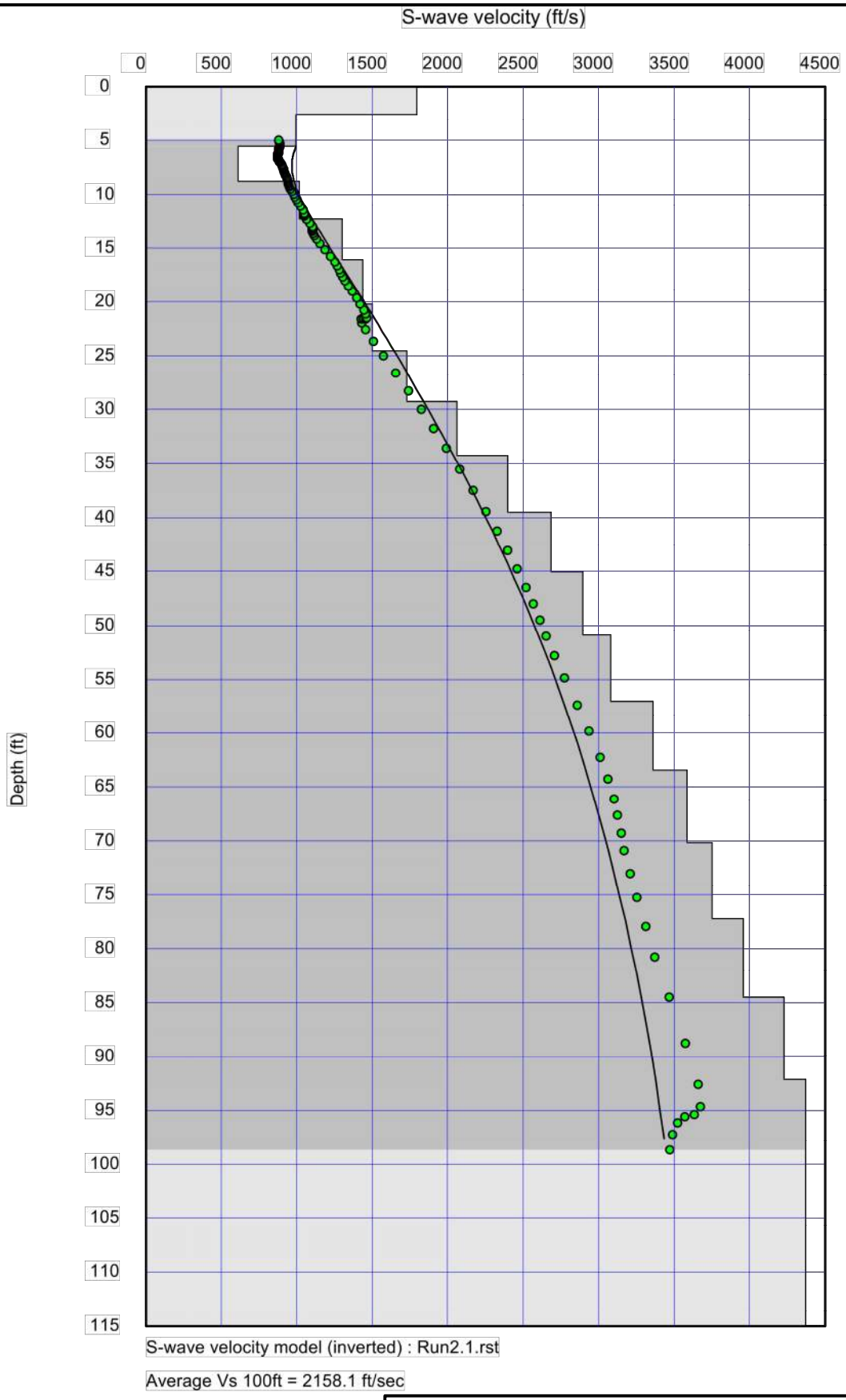
Building Boring Fence Diagram

DATE: January 10, 2022

Project Number: 277340

PALMERTON & PARRISH, INC.
GEOTECHNICAL AND MATERIALS ENGINEERS/MATERIALS TESTING LABORATORIES/ENVIRONMENTAL SERVICES

FIGURE 3



Project: W.W. Hastings Replacement Hospital & Parking Garage
Client: Childers Architect

Shear Wave Velocity Vs. Depth Model

DATE: January 10, 2022

Project Number: 277340

PALMERTON & PARRISH, INC.
GEOTECHNICAL AND MATERIALS ENGINEERS/MATERIALS TESTING LABORATORIES/ENVIRONMENTAL SERVICES

FIGURE 4

S:_MASTER PROJECT FILE\2021\OK\C\Childers Architect-277340-WW Hastings Replacement Hospital-Sub\Figures\MASW Output - Figure 3.dwg

APPENDIX I

BORING LOGS & KEY TO SYMBOLS

4168 W Kearney Street
65803
Telephone: 417-864-6000
Fax: 417-864-6000

GEOTECHNICAL BORING LOG

BORING NUMBER 1

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/1/21 **COMPLETED** 12/1/21
SURFACE ELEVATION 917.0 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		TOPSOIL, Brown, Moist, Soft — 0.2 ft	SPT 1		3-3-3 (6)	0.75	915
			CLAYEY GRAVEL, w/ Sand, Brown, Loose to Very Dense, Moist (GC)	SPT 2		38-53-48 (101)		
5			5.5 ft					
			FAT CLAY, w/ Gravel, Red, Tan & Brown, Very Hard, Moist (CH)	ST 3	71		4.5	10.18 910
			8.0 ft					
			SHALEY LEAN CLAY, Brown, Tan & Gray, Hard, Moist (CL)	SPT 4		15-20-21 (41)	3.25	
10								905
			-Red, Tan & Gray, Stiff Below 13.5'	SPT 5		3-6-8 (14)	3	
15			18.2 ft					900
			ARGILLACEOUS LIMESTONE, Brown Tan, Highly Weathered, Very Soft — 19.0 ft	SPT 6		75/5"		
20	CORE BARREL - 2" I.D.		ARGILLACEOUS LIMESTONE, Gray, Fine Crystalline, Soft to Medium Hard	NQ 1	80 (75)			895
			21.9 ft					
			VOID — 22.9 ft					
			ARGILACEOUS LIMESTONE, Gray, Fine Crystalline, Soft to Moderately Hard					
25				NQ 2	100 (58)			890
			27.8 ft					
			SHALE, Brown Tan, Weathered, Soft *Possible Marlstone*					
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

(Continued Next Page)

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GEOTECHNICAL BORING LOG

BORING NUMBER 1

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30			SHALE, Brown Tan, Weathered, Soft *Possible Marlstone* (continued) 31.8 ft	NQ 3	100 (67)				
			CHERTY LIMESTONE, Gray & White, Fine Crystalline, Medium Hard, Medium Bedded 34.0 ft						885

Bottom of borehole at 34.0 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER 2

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/1/21 **COMPLETED** 12/2/21
SURFACE ELEVATION 914.2 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES Hole crooked switched to tricone at 24'

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.	CONCRETE 0.3 ft / 0.8 ft					914
		AGGREGATE BASEROCK	SPT 1		29-32-33 (65)	3.25	
		LEAN CLAY, w/ Gravel, Brown, Very Hard, Moist (CL) 3.0 ft					
		LEAN TO FAT CLAY, Trace sand & Gravel, Red Tan, Very Stiff, Moist (CL-CH)	SPT 2		6-11-14 (25)	4.5	
5		6.0 ft					910
		SHALEY FAT CLAY , Brown Tan, Hard, Moist (CH)	SPT 3		9-15-23 (38)	4.5	
			SPT 4		11-18-23 (41)		
10							905
			ST 5	100		4.5	
15							900
		18.0 ft					
		FAT CLAY, Red Brown, Stiff, Moist (CH)	SPT 6		5-6-6 (12)	3.75	
20		21.7 ft					895
	ROTARY - 3.625" CORE BARREL - 2" I.D.	ARGILLACEOUS LIMESTONE, Brown Tan, Highly Weathered, Soft to Moderately Hard 23.0 ft	NQ 1	50 (50)			
		CLAY SEAM OR POSSIBLE VOID 24.0 ft					
		ARGILLACEOUS LIMESTONE, Brown Tan, Highly Weathered, Soft to Medium Hard 24.5 ft	SPT 7		18-75/0"	1	890
25		CHERT, White, Very Dense					
			SPT 8		75/0"		885
30							

(Continued Next Page)

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 2

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CHERT, White, Very Dense *(continued)*					
			33.0 ft					
			ARGILLACEOUS LIMESTONE, Brown Tan, Highly Weathered, Soft to Medium Hard	SPT 9		47-27-11 (38)	1	
			35.0 ft					880
35			CHERT, w/ Clay Layers, White & Red, Weathered, Very Dense					
				SPT 10		8-8-75/5"		
40								875
			43.0 ft					
			Bottom of borehole at 43.0 feet.	SPT 11		75/0"		

DRY UNIT WT (pcf) ◆ 20 40 60 80 100
▲ N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) ■ 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 3

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 11/29/21 **COMPLETED** 11/30/21
SURFACE ELEVATION 912.6 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** CME-1050
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		TOPSOIL, Brown, Soft, Moist, Grass Covered — 0.2 ft GRAVELLY LEAN CLAY, Red Brown, Stiff to Very Stiff, Moist (CL)	SPT 1		4-4-5 (9)		
				SPT 2		9-12-9 (21)	2.75	910
5			5.5 ft SHALEY FAT CLAY, Tan, Brown & Gray, Hard to Stiff, Moist (CH)	SPT 3		7-13-21 (34)		
				SPT 4		14-18-17 (35)	4.5	905
10								
				SPT 5		5-5-10 (15)	2.75	900
15								
				SPT 6		4-4-5 (9)	0.75	895
20								
			23.0 ft SHALE, Brown Tan, Very Soft, Highly Weathered	SPT 7		7-14-25 (39)	4.5	890
25			28.0 ft LIMESTONE, w/ Alternating Chert Layers & Nodules, Gray & White, Moderately Hard to Hard, Medium Bedded, Fine Crystalline	NQ 1	100 (100)			885
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

(Continued Next Page)

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GEOTECHNICAL BORING LOG

BORING NUMBER 3

CLIENT Childers Architect

PROJECT NAME W.W. Hastings Replacement Hospital

PROJECT NO. 277340

PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30	CORE BARREL - 2" I.D.		LIMESTONE, w/ Alternating Chert Layers & Nodules, Gray & White, Moderately Hard to Hard, Medium Bedded, Fine Crystalline *(continued)*	NQ 2	100 (72)				
									880
35				NQ 3	100 (40)				
			38.3 ft						875

Bottom of borehole at 38.3 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER 4

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/2/21 **COMPLETED** 12/2/21
SURFACE ELEVATION 917.2 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		TOPSOIL, Brown, Soft, Moist, Grass Covered — 0.2 ft					915
			LEAN CLAY, w/ Gravel, Red Brown, Very Stiff, Moist (CL) — 0.5 ft	SPT 1		6-8-17 (25)		
			CLAYEY GRAVEL, Red Brown, Dense, Moist (GC)					
			5.0 ft	SPT 2		12-17-15 (32)		
5			LEAN CLAY, Trace Sand, Red Tan, Stiff, Moist (CL)					910
			8.0 ft	SPT 3		3-6-9 (15)	2.75	
			FAT CLAY, Red Tan, Very Stiff, Moist (CH)	ST 4	100		3.75	
10								905
				SPT 5		6-8-9 (17)	3	
15			18.0 ft					900
			SHALEY FAT CLAY, Tan, Very Stiff, Moist (CH)	SPT 6		6-9-14 (23)	3.5	
20			23.5 ft					895
			CHERTY LIMESTONE, White & Gray, Weathered, Soft to Medium Hard	SPT 7		75/3"	2.5	
25			25.5 ft					890
			CHERTY LIMESTONE, w/ Numerous Chert Layers & Nodules & Occasional Shaley/Argillaceous Seams, Medium to Moderately Hard, Medium Bedded, Fine Crystalline	NQ 1	100 (32)			
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

(Continued Next Page)

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GEOTECHNICAL BORING LOG

BORING NUMBER 4

CLIENT Childers Architect **PROJECT NAME** W.W. Hastings Replacement Hospital

PROJECT NO. 277340 **PROJECT LOCATION** Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30	CORE BARREL - 2" I.D.		CHERTY LIMESTONE, w/ Numerous Chert Layers & Nodules & Occasional Shaley/Argillaceous Seams, Medium to Moderately Hard, Medium Bedded, Fine Crystalline *(continued)*	NQ 2	97 (78)				885
35			35.5 ft	NQ 3	100 (44)				

Bottom of borehole at 35.5 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER 5

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/2/21 **COMPLETED** 12/3/21
SURFACE ELEVATION 914.9 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		0.3 ft CONCRETE 0.8 ft AGGREGATE BASE GRAVELLY LEAN CLAY, Brown Red, Stiff to Hard, Moist (CL)	SPT 1		8-23-36 (59)	4	
				SPT 2		5-8-6 (14)	1.5	
5			6.0 ft SHALE, Gray, Highly Weathered, Very Soft	SPT 3		23-63-60 (123)	4.5	910
			9.8 ft	SPT 4		3-3-75/3"	4.25	
10	CORE BARREL - 2" I.D.		ARGILLACEOUS LIMESTONE, Dark Gray and Tan, Fine Crystalline, Slightly Weathered, Medium to Moderately Hard	NQ 1	100 (34)			905
			13.3 ft -Highly Weathered & Very Soft Shale/Mudstone Layer Between 13.3' and 14.3' (12") 14.3 ft 15.0 ft ARGILLACEOUS LIMESTONE, Dark Gray and Tan, Fine Crystalline, Slightly Weathered, Medium Hard					
15			-Highly Weathered & Very Soft Shale/Mudstone Layer Between 15.0' and 16.7' (20") 16.7 ft LIMESTONE, Dark Gray, Slightly Weathered, Medium Hard	NQ 2	100 (60)			900
20				NQ 3	100 (95)			895
			25.2 ft	NQ 4	100 (56)			
25			Bottom of borehole at 25.2 feet.					890

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 6

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/3/21 **COMPLETED** 12/3/21
SURFACE ELEVATION 915.5 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.3 ft					915
			AGGREGATE BASE 1.0 ft					
			FAT CLAY, Trace Gravel, Red Gray, Stiff to Hard, Moist (CH)	SPT 1		3-5-9 (14)	4.5	
			-Tan Brown Below 3'	SPT 2		6-17-23 (40)	4.5	
5			5.5 ft					910
			FAT CLAY, Shaley, Tan Brown, Very Stiff to Hard, Moist (CH)	SPT 3		15-15-14 (29)	4.5	
			9.0 ft	SPT 4		3-75/2"	0.25	
			ARGILLACEOUS LIMESTONE, Gray & Tan, Medium Hard, Medium Bedded, Fine Crystalline 10.1 ft					
10	CORE BARREL - 2" I.D.		SHALE, Brown Tan, Highly Weathered, Very Soft -Wash Away from 10.9' to 11.7' (No Rod Drop)	NQ 1	77 (44)			905
			12.5 ft					
			ARGILLACEOUS LIMESTONE, Gray, Medium to Moderately Hard, Medium Bedded, Fine Crystalline	NQ 2	100 (93)			
15								900
20			-Wash Away from 20.7' to 20.9' (No Rod Drop)	NQ 3	97 (95)			895
25			25.9 ft	NQ 4	100 (92)			890

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

Bottom of borehole at 25.9 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER 7

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/7/21 **COMPLETED** 12/7/21
SURFACE ELEVATION 917.4 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		TOPSOIL, Brown, Soft, Moist, Grass Covered — 0.3 ft CLAYEY GRAVEL, With Sand, Red, Dense to Very Dense, Moist (GC)	SPT 1		6-8-18 (26)	1.75	915
				SPT 2		12-42-45 (87)		
5				SPT 3		18-27-35 (62)		910
			8.0 ft FAT CLAY, Red, Very Stiff, Moist (CH)	SPT 4		6-8-11 (19)	4.5	
10								905
				SPT 5		6-12-15 (27)	4	
15			16.0 ft FAT CLAY, Shaley, Tan Gray, Very Stiff, Moist (CH)					900
				SPT 6		8-9-15 (24)	3.25	
20			23.5 ft					895
			23.9 ft CHERT BOULDER, Very Dense	SPT 7		75/5"	2.25	
25			ALTERNATING LAYERS OF CHERT BOULDERS & FAT CLAY, White & Red, Very Dense or Very Hard, Moist					890
				SPT 8		18-33-75/3"	2	
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 7

CLIENT Childers Architect

PROJECT NAME W.W. Hastings Replacement Hospital

PROJECT NO. 277340

PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30			ALTERNATING LAYERS OF CHERT BOULDERS & FAT CLAY, White & Red, Very Dense or Very Hard, Moist *(continued)*						
			33.6 ft	SPT 9	0	75/1"			885
			Bottom of borehole at 33.6 feet.						

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GEOTECHNICAL BORING LOG

BORING NUMBER 8

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/7/21 **COMPLETED** 12/7/21
SURFACE ELEVATION 915.8 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.3 ft / 0.8 ft					915
			AGGREGATE BASE					
			LEAN TO FAT CLAY, Scattered Chert, Red Tan, Very Stiff, Moist (CL-CH) 3.0 ft	SPT 1		6-8-11 (19)	4	
			LEAN CLAY, Trace Sand & Gravel, Brown Tan, Hard, Moist (CL) *1.46% Swell* *2.00 TSF Swell Pressure* 5.5 ft	ST 2	95		4.5	10.13 122.1406
5			LEAN TO FAT CLAY, Brown, Tan & Red, Stiff, Moist (CL-CH)	SPT 3		5-5-5 (10)	1.25	910
				ST 4	100		1.5	
10			13.0 ft					905
			ARGILLACEOUS LIMESTONE, Weathered, Dark Gray, Fine Crystalline, Soft to Medium Hard	SPT 5		42-11-3 (14)	1.5	
15			16.0 ft					900
	CORE BARREL - 2" I.D.		ARGILLACEOUS LIMESTONE, Dark Gray, Medium to Moderately Hard, Medium Bedded, Fine Crystalline	NQ 1	100 (97)			
			20.3 ft					
20			SHALE, Dark Gray & Tan, Soft to Medium Hard, Medium Bedded *Possible Marlstone*	NQ 2	100 (98)			895
25			-Extremely Soft Below 25'	NQ 3	100 (58)			890
			27.0 ft					
			CHERT, Limestone & Shale Matrix, White, Gray & Green, Medium Hard to Moderately Hard, Fine Crystalline, Slightly Fractured	NQ	100			
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 8

CLIENT Childers Architect **PROJECT NAME** W.W. Hastings Replacement Hospital

PROJECT NO. 277340 **PROJECT LOCATION** Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30			31.1 ft	4	(71)				885

Bottom of borehole at 31.1 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER 9

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/6/21 **COMPLETED** 12/6/21
SURFACE ELEVATION 917.3 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.3 ft AGGREGATE BASE 0.9 ft CLAYEY GRAVEL, Red Brown, Very Dense to Dense, Moist (GC)	SPT 1		9-27-27 (54)	4.5	915
				SPT 2		17-21-27 (48)	4.5	
5			6.0 ft SANDY LEAN CLAY, Scattered Gravel, Red Tan, Very Stiff, Moist (CL)	SPT 3		8-9-11 (20)	4.5	910
			8.0 ft FAT CLAY, Tan, Very Stiff to Stiff, Moist (CH) *0.77% Swell* *1.00 TSF Swell Pressure*	ST 4	100		4.5	
10								905
				SPT 5		3-5-6 (11)	1.25	
15			16.0 ft FAT CLAY, Shaley, Tan Gray, Stiff, Moist (CH)					900
				ST 6	100		1.5	
20			22.8 ft					895
	CORE BARREL - 2" I.D.		CHERT, White, Moderately Hard, Thin Bedded, Slightly Fractured, Microcrystalline	NQ 1	100 (0)			
25			25.4 ft HIGHLY WEATHERED LIMESTONE & GRAVELLY CLAY LAYERS, Red & Gray, Soft to Medium Hard	NQ 2	52 (30)			890
			28.6 ft CHERTY LIMESTONE, Gray & White, Medium Hard, Thin Bedded, Fine Crystalline 29.7 ft					
30								

DRY UNIT WT (pcf) ◆ 20 40 60 80 100
N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) ◻ 1 2 3 4

(Continued Next Page)

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GEOTECHNICAL BORING LOG

BORING NUMBER 9

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CHERT w/ WEATHERED LIMESTONE LAYERS, Gray & White, Medium Hard, Highly Fractured Chert *(continued)*	NQ 3	65 (18)			885
			34.1 ft					
35			CLAYEY GRAVEL, Red & White, Very Dense, Moist (GC)	SPT 7		30-75/5"		
			38.0 ft	SPT 8		75/2"		880
40			GRAVELLY FAT CLAY, Red & White, Stiff, Moist (CH)	SPT 9		11-9-5 (14)		875
45			49.0 ft	SPT 10		2-5-9 (14)		870

Bottom of borehole at 49.0 feet.

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 10

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/9/21 **COMPLETED** 12/9/21
SURFACE ELEVATION 917.5 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		TOPSOIL, Brown, Soft, Moist, Grass Covered — 0.3 ft					
			GRAVELLY LEAN CLAY, Brown Red, Stiff, Moist (CL) — 2.0 ft	SPT 1		3-3-8 (11)	4	
			LEAN CLAY, Red Gray, Stiff to Very Stiff, Moist (CL)	SPT 2		3-5-5 (10)	1.25	915
5				SPT 3		6-6-12 (18)	3.25	
			8.0 ft					910
			CLAYEY GRAVEL, Red Brown, Very Dense, Moist (GC)	SPT 4		15-21-50 (71)	1.5	
10			12.0 ft					905
			FAT CLAY, Scattered Gravel, Red Tan, Stiff to Very Hard, Moist (CH)	SPT 5		5-6-8 (14)	2.5	
15								900
			19.0 ft	SPT 6		27-75/5"	2.75	
20			CHERT, w/ Occasional Clay Seams, White, Very Dense, Slightly Moist	SPT 7	0	75/2"		895
25				SPT 8	0	75/1"		890
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

(Continued Next Page)

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GEOTECHNICAL BORING LOG

BORING NUMBER 10

CLIENT Childers Architect

PROJECT NAME W.W. Hastings Replacement Hospital

PROJECT NO. 277340

PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30			CHERT, w/ Occasional Clay Seams, White, Very Dense, Slightly Moist *(continued)*						
			33.1 ft	SPT 9	0	75/1"			885
			Bottom of borehole at 33.1 feet.						

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GEOTECHNICAL BORING LOG

BORING NUMBER 11

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/8/21 **COMPLETED** 12/9/21
SURFACE ELEVATION 916.1 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.4 ft AGGREGATE BASE 0.7 ft CLAYEY GRAVEL, Red, Very Dense, Moist (GC) 3.0 ft	SPT 1		11-30-47 (77)	3	915
			LEAN TO FAT CLAY, Scattered Gravel, Red Tan & Gray, Stiff to Very Stiff, Moist (CL-CH)	SPT 2		12-6-8 (14)	0.75	
5				ST 3	96		4.5	910
				SPT 4		5-8-9 (17)	2	
10				ST 5	100		4.5	905
			15.0 ft CHERT, w/ Scattered Clay Seams & Layers, White & Red, Medium Dense to Very Dense, Slightly Moist	SPT 6		75/1"		900
15								
20				SPT 7		21-69-71 (140)	1.75	895
25								890
				SPT 8		8-6-6 (12)	0.5	
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 11

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CHERT, w/ Scattered Clay Seams & Layers, White & Red, Medium Dense to Very Dense, Slightly Moist *(continued)*	SPT 9	0	75/1"		885
35				SPT 10		15-6-5 (11)	0.25	880
40				SPT 11		15-75/3"		875
45			48.2 ft	SPT 12	0	75/2"		870
			Bottom of borehole at 48.2 feet.					

DRY UNIT WT (pcf) ◆ 20 40 60 80 100
▲ N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 12

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/8/21 **COMPLETED** 12/8/21
SURFACE ELEVATION 918.0 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES Hole lost circ. struggling to pull out tricone and get spoon down. Offset due to first hole being crooked and collapsing. No luck on second hole.

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.3 ft AGGREGATE BASE 0.9 ft CLAYEY GRAVEL, Red & Tan, Very Dense, Moist (GC)	SPT 1		18-21-53 (74)		
				SPT 2		30-42-75/5"		915
5			5.0 ft FAT CLAY, Trace Gravel, Red Tan, Very Stiff, Moist (CH)	SPT 3		12-9-9 (18)	2.5	
				ST 4	54		4.5	910
10								
				SPT 5		5-9-15 (24)	2.75	905
15			18.0 ft CHERT, Dark Gray, Very Dense	SPT 6		30-75/4"		900
20				SPT 7		5-75/5"		895
25				SPT 8		75/1"		890
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 12

CLIENT Childers Architect

PROJECT NAME W.W. Hastings Replacement Hospital

PROJECT NO. 277340

PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CHERT, Dark Gray, Very Dense *(continued)*						
			32.0 ft						
			FAT CLAY, Scattered Gravel, Red, Medium Stiff, Moist (CH)	SPT 9		9-5-3 (8)	0.25	▲ ○	885
35			36.0 ft						
			CHERT, White Gray, Very Dense						
			38.0 ft						
			Bottom of borehole at 38.0 feet.						880

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GEOTECHNICAL BORING LOG

BORING NUMBER 13

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/7/21 **COMPLETED** 12/8/21
SURFACE ELEVATION 919.5 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES Slipped, lost 4" of core.

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		TOPSOIL, Brown, Soft, Moist, Grass Covered 0.2 ft LEAN CLAY, Scattered Gravel, Brown, Moist (CL) 2.0 ft	SPT 1		5-11-8 (19)	2.25	
			CLAYEY GRAVEL, Brown Red, Very Dense, Moist (GC)	SPT 2		20-56-48 (104)	3	915
5			5.5 ft LEAN CLAY, Red, Tan & Gray, Very Stiff to Hard, Moist (CL)	SPT 3		6-9-12 (21)	4.5	
				SPT 4		11-17-18 (35)	4.5	910
10			-Shaley Below 13'	SPT 5		18-30-21 (51)	4	
15								905
			-Very Soft Below 18.5'	SPT 6		0-0-0 (0)		
20								900
			23.5 ft					
	CORE BARREL - 2" I.D.		ARGILLACEOUS LIMESTONE, Gray & Tan, Fine Crystalline, Medium Hard, Thin Bedded 24.6 ft SHALE, Highly Weathered, Brown, Extremely Soft *Possible Marlstone* 25.3 ft	SPT 7	100 (100)	75/1"	0.25	
25				NQ 1				895
			CHERTY LIMESTONE, White & Gray, Medium to Moderately Hard, Thin to Medium Bedded, Fine Crystalline	NQ 2	100 (45)			
				NQ	83			890
30								

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DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 13

CLIENT Childers Architect **PROJECT NAME** W.W. Hastings Replacement Hospital

PROJECT NO. 277340 **PROJECT LOCATION** Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30			31.0 ft	3	(71)				

Bottom of borehole at 31.0 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER **20**

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/9/21 **COMPLETED** 12/10/21
SURFACE ELEVATION 916.8 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		TOPSOIL, Brown, Soft, Moist, Grass Covered — 0.1 ft	SPT 1		2-3-5 (8)	0.75	915
			LEAN CLAY, Scattered Gravel, Dark Brown, Medium Stiff, Moist (CL) — 2.5 ft					
			CLAYEY GRAVEL, With Sand, Red, Dense to Very Dense, Moist (GC)	SPT 2		11-17-18 (35)	4.5	
5				SPT 3		17-36-35 (71)		910
			8.0 ft					
			LEAN CLAY, Red, Tan & Gray, Hard, Moist (CL) — 9.0 ft	SPT 4		14-75/3"	3	
			CHERT, White, Very Dense					
10								905
				SPT 5		75/0"		
15								900
				SPT 6		75/0"		
20								895
			23.0 ft					
			CLAYEY GRAVEL, Occasional Boulders, Red & White, Dense to Very Dense, Slightly Moist (GC)	SPT 7		12-48-32 (80)	0.25	
25								890
				SPT 8		75/1"		
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 20

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 / N VALUE 20 40 60 80 / PL MC LL 20 40 60 80 / SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CLAYEY GRAVEL, Occasional Boulders, Red & White, Dense to Very Dense, Slightly Moist (GC) *(continued)*						885
				SPT 9		45-57-72 (129)			
35									880
				SPT 10		5-12-23 (35)	0.5		
40									875
				SPT 11		15-23-32 (55)	0.5		
45									870
			50.0 ft	SPT 12		23-24-26 (50)	1		
50			Bottom of borehole at 50.0 feet.						

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GEOTECHNICAL BORING LOG

BORING NUMBER 21

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/13/21 **COMPLETED** 12/13/21
SURFACE ELEVATION 916.5 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.3 ft AGGREGATE BASE 1.0 ft CLAYEY GRAVEL, w/ Scattered Clay and Chert Layers, Red, Brown & White, Medium Dense to Very Dense, Moist (GC)	SPT 1		24-27-45 (72)		915
				SPT 2		27-45-68 (113)		
5				SPT 3		20-11-11 (22)		910
			8.0 ft FAT CLAY, Trace Gravel and Sand, Red and Tan, Hard, Moist (CH)	ST 4	95		4.5	5.13
10			12.0 ft CLAYEY GRAVEL, w/ Scattered Clay and Chert Layers, Red, Brown & White, Dense to Very Dense, Moist (GC)	SPT 5		38-60-39 (99)		905
15								900
				SPT 6		18-35-26 (61)		
20								895
				SPT 7		23-27-75/5"		
25								890
				SPT 8		8-20-9 (29)	0.25	
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 21

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CLAYEY GRAVEL, w/ Scattered Clay and Chert Layers, Red, Brown & White, Dense to Very Dense, Moist (GC) *(continued)*					885
				SPT 9	0	75/1"		
35								880
				SPT 10		11-14-18 (32)	1	
40								875
				SPT 11	0	75/2"		
45								870
				SPT 12		11-15-12 (27)	0.25	
			50.0 ft					
50			Bottom of borehole at 50.0 feet.					

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 22

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/14/21 **COMPLETED** 12/14/21
SURFACE ELEVATION 919.4 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.3 ft / 1.0 ft					
			AGGREGATE BASE					
			CLAYEY GRAVEL, w/ Sand & Chert Cobbles, Red, Brown, & Gray, Very Dense, Moist (GC)	SPT 1		26-39-36 (75)		
				SPT 2		38-75/5"		
			4.5 ft					
5			FAT CLAY, Scattered Gravel, Red Tan & Gray, Stiff to Very Stiff, Moist (CH)	SPT 3		5-6-8 (14)		915
				SPT 4		18-14-15 (29)	1.5	
10								910
				SPT 5		6-5-21 (26)	2.25	
			15.0 ft					
15			CLAYEY GRAVEL, w/ Sand & Chert Cobbles, Red, Tan Gray, Dense to Very Dense, Moist (GC)					905
				SPT 6		15-15-11 (26)		
20								900
				SPT 7		75/1"		
25								895
				SPT 8		47-45-32 (77)	1	
			30.0 ft					890
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 22

CLIENT Childers Architect

PROJECT NAME W.W. Hastings Replacement Hospital

PROJECT NO. 277340

PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CHERT, White, Very Dense	SPT 9	0	75/1"			885
35				SPT 10		75/0"			880
40			43.2 ft	SPT 11	0	75/2"			

Bottom of borehole at 43.2 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER 23

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/15/21 **COMPLETED** 12/15/21
SURFACE ELEVATION 916.5 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.4 ft AGGREGATE BASE 0.6 ft CLAYEY SAND, w/ Gravel, Red Brown, Very Dense, Moist (SC)	SPT 1		21-41-68 (109)		915
				SPT 2		32-54-47 (101)		
5			6.0 ft FAT CLAY, w/ Gravel, Red Tan, Hard, Moist (CH)	SPT 3		11-15-24 (39)	3	910
				SPT 4		38-30-27 (57)	2.25	
10			10.0 ft CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Dense to Very Dense, Slightly Moist (GC)					905
				SPT 5		44-74-75/0"		
15								900
				SPT 6		20-11-17 (28)	2.25	
20								895
				SPT 7		33-30-11 (41)	0.25	
25			28.0 ft CHERT, w/ Occasional Clay Seams, White & Red, Very Dense	SPT 8		75/0"		890
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

(Continued Next Page)

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GEOTECHNICAL BORING LOG

BORING NUMBER 23

CLIENT Childers Architect

PROJECT NAME W.W. Hastings Replacement Hospital

PROJECT NO. 277340

PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CHERT, w/ Occasional Clay Seams, White & Red, Very Dense *(continued)*	SPT 9		75/2"			885
35			38.1 ft Bottom of borehole at 38.1 feet.	SPT 10		75/1"			880

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GEOTECHNICAL BORING LOG

BORING NUMBER 24

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/14/21 **COMPLETED** 12/15/21
SURFACE ELEVATION 917.4 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.6 ft / 0.9 ft AGGREGATE BASE CLAYEY GRAVEL, With Sand, Red, Tan & White, Dense, Moist (GC)	SPT 1		9-18-24 (42)		915
				SPT 2		12-15-24 (39)		
5			7.5 ft CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Dense to Very Dense, Slightly Moist (GC)	SPT 3		15-14-17 (31)		910
				SPT 4		75/5"	0.25	
10								905
				SPT 5		9-20-21 (41)	1	
15								900
				SPT 6		27-75/4"	1.25	
20								895
				SPT 7		15-45-45 (90)	0.75	
25								890
				SPT 8		14-17-71 (88)		
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

(Continued Next Page)

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GEOTECHNICAL BORING LOG

BORING NUMBER 24

CLIENT Childers Architect **PROJECT NAME** W.W. Hastings Replacement Hospital

PROJECT NO. 277340 **PROJECT LOCATION** Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Dense to Very Dense, Slightly Moist (GC) *(continued)*	SPT 9		75/1"			885
35				SPT 10		75/5"			880
40			43.2 ft	SPT 11	0	75/2"			875
			Bottom of borehole at 43.2 feet.						

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GEOTECHNICAL BORING LOG

BORING NUMBER 25

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/14/21 **COMPLETED** 12/14/21
SURFACE ELEVATION 920.4 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.3 ft AGGREGATE BASE 0.7 ft CLAYEY GRAVEL, Red Brown, Very Dense, Moist (GC)	SPT 1		35-60-63 (123)		920
				SPT 2		30-54-36 (90)		
5				SPT 3		39-50-69 (119)		915
			8.0 ft FAT CLAY, Brown Tan, Stiff to Very Stiff to Hard, Moist (CH)	SPT 4		26-11-9 (20)		
10								910
			15.0 ft CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Medium Dense to Dense, Slightly Moist (GC)	SPT 5		8-15-23 (38)	1.25	
15								905
				SPT 6		42-12-21 (33)		
20								900
				SPT 7		15-8-42 (50)		
25								895
				SPT 8		5-8-15 (23)	0.25	
			30.0 ft					
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 25

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CHERT, White, Very Dense	SPT 9		75/5"			890
35				SPT 10		75/0"			885
40			43.1 ft						880
			Bottom of borehole at 43.1 feet.	SPT 11		75/1"			

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GEOTECHNICAL BORING LOG

BORING NUMBER 26

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/15/21 **COMPLETED** 12/20/21
SURFACE ELEVATION 918.7 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		TOPSOIL, Brown, Soft, Moist, Grass Covered — 0.2 ft	SPT 1		3-5-8 (13)	1.5	
			LEAN CLAY, Scattered Gravel, Brown, Stiff, Moist (CL) — 2.0 ft					
			CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Very Dense, Slightly Moist (GC)	SPT 2		75-8/0"		915
5				SPT 3		42-75/3"	0.5	
				SPT 4		27-75/2"	0.5	910
			— 10.0 ft					
10			CHERT, White, Very Dense					
				SPT 5		11-75/4"	1.25	905
15								
				SPT 6		62-75/4"		900
20								
				SPT 7		75/1"		895
25								
				SPT 8		75/2"		890
30								

DRY UNIT WT (pcf) ◆ 20 40 60 80 100
▲ N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) ■ 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 26

CLIENT Childers Architect **PROJECT NAME** W.W. Hastings Replacement Hospital

PROJECT NO. 277340 **PROJECT LOCATION** Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30			CHERT, White, Very Dense *(continued)*						
			33.1 ft	SPT 9		75/1"			
			Bottom of borehole at 33.1 feet.						

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GEOTECHNICAL BORING LOG

BORING NUMBER 27

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/16/21 **COMPLETED** 12/16/21
SURFACE ELEVATION 920.1 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		TOPSOIL, Brown, Soft, Moist, Grass Covered 0.2 ft CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Medium Dense to Very Dense, Slightly Moist (GC)	SPT 1		6-8-12 (20)	3	920
				SPT 2		54-35-23 (58)		
5				SPT 3		75/0"		915
				SPT 4		75/1"		
10				SPT 5		75/5"		910
			15.0 ft CHERT, White, Very Dense					
15				SPT 6		75/0"		905
20			23.0 ft CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Dense to Very Dense, Slightly Moist (GC)	SPT 7		11-17-18 (35)		900
25				SPT 8		75/1"		895
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 27

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) 20 40 60 80 100 N VALUE 20 40 60 80 PL MC LL 20 40 60 80 SHEAR STRENGTH (ksf) 1 2 3 4	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Dense to Very Dense, Slightly Moist (GC) *(continued)*	SPT 9		27-23-18 (41)			890
35				SPT 10		75/0"			885
40				SPT 11		75/0"			880
45				SPT 12		6-14-75/3"	1		875
			49.3 ft Bottom of borehole at 49.3 feet.						

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GEOTECHNICAL BORING LOG

BORING NUMBER 28

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/16/21 **COMPLETED** 12/16/21
SURFACE ELEVATION 921.9 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		TOPSOIL, Brown, Soft, Moist, Grass Covered — 0.2 ft CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Medium Dense to Very Dense, Slightly Moist (GC)	SPT 1		8-8-6 (14)	3	920
				SPT 2		41-42-42 (84)		
5				SPT 3		75/0"		915
				SPT 4		24-12-75/3"		
10								910
				SPT 5		75/4"	0.25	
15								905
			18.0 ft CHERT, White, Very Dense	SPT 6		75/0"		
20								900
				SPT 7		75/0"		
25								895
				SPT 8		75/0"		
30								

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

(Continued Next Page)

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GEOTECHNICAL BORING LOG

BORING NUMBER **28**

CLIENT Childers Architect **PROJECT NAME** W.W. Hastings Replacement Hospital

PROJECT NO. 277340 **PROJECT LOCATION** Tahlequah, Oklahoma

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
30	ROTARY - 3.625" O.D.		CHERT, White, Very Dense *(continued)*					
			32.5 ft					890
			CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Medium Dense to Very Dense, Slightly Moist (GC)	SPT 9		8-8-15 (23)	0.25	
35								885
				SPT 10		18-27-23 (50)		
40								880
				SPT 11	0	75/2"		
45								875
			49.3 ft	SPT 12		53-47-75/3"	0.25	

Bottom of borehole at 49.3 feet.

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER **29**

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/20/21 **COMPLETED** 12/21/21
SURFACE ELEVATION 916.8 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.3 ft AGGREGATE BASE 0.8 ft CLAYEY SAND, With Gravel, w/ Chert Boulders & Clay Layers, Red & White, Medium Dense to Very Dense, Slightly Moist (SC)	SPT 1		14-17-18 (35)		915
				SPT 2		17-12-75/5"	3	
5				SPT 3		75/1"		910
				SPT 4		75/0"		
10								905
				SPT 5		75/3"		
15								900
				SPT 6		15-30-36 (66)		
20								895
				SPT 7		6-11-8 (19)	0.5	
25								890
			30.0 ft	SPT 8		75/3"	0.5	

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

30 Bottom of borehole at 30.0 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER 30

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/21/21 **COMPLETED** 12/21/21
SURFACE ELEVATION 916.0 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.3 ft / 0.9 ft AGGREGATE BASE CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Dense to Very Dense, Slightly Moist (GC)	SPT 1		24-18-11 (29)		915
				SPT 2		21-75/5"		
5				SPT 3		29-75/5"	2.25	910
				SPT 4		75/5"	1	
10			11.5 ft CHERT, White, Very Dense					905
				SPT 5		75/1"		
15								900
			18.5 ft CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Very Dense, Slightly Moist (GC)	SPT 6		75/4"		
20								895
				SPT 7		38-45-44 (89)		
25								890
				SPT 8		75/1"		
			30.0 ft					

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

Bottom of borehole at 30.0 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER 32

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/22/21 **COMPLETED** 12/22/21
SURFACE ELEVATION 917.5 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.4 ft					
			AGGREGATE BASE 1.0 ft					
			CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Very Dense, Slightly Moist (GC)	SPT 1		15-38-75/5"	0.5	
				SPT 2		75/3"		915
5				SPT 3		75/2"		
				SPT 4		18-36-75/0"	0.75	910
10								
				SPT 5		75/1"		905
15								
				SPT 6		75/0"		900
20			20.5 ft CHERT, White, Very Dense					
				SPT 7		75/0"		895
25								
			30.0 ft					890
30			Bottom of borehole at 30.0 feet.					

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

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GEOTECHNICAL BORING LOG

BORING NUMBER 33

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma
DATE STARTED 12/22/21 **COMPLETED** 12/22/21
SURFACE ELEVATION 917.1 ft **BENCHMARK EL.**
DRILLER MR **DRILL RIG** 2019 CME-55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY BC **CHECKED BY** MM
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION (Unified Soil Classification System)	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	ROTARY - 3.625" O.D.		CONCRETE 0.5 ft AGGREGATE BASE 1.3 ft GRAVELLY LEAN CLAY, With Sand, w/ Chert Boulders & Clay Layers, Red & White, Very Dense, Slightly Moist (CL)	SPT 1		14-15-20/0"		915
				SPT 2		9-26-33/0"		
5				SPT 3		39-47-66/0"		910
				SPT 4		44-53-75/0"		
10								905
				SPT 5		11-63-42 (105)	2	
15			16.0 ft CHERT, White, Very Dense					900
				SPT 6		75/2"		
20								895
			24.0 ft CLAYEY GRAVEL, w/ Chert Boulders & Clay Layers, Red & White, Very Dense, Slightly Moist (GC)	SPT 7		75/1"		
25								890
			30.0 ft	SPT 8		75/2"		

DRY UNIT WT (pcf) 20 40 60 80 100
N VALUE 20 40 60 80
PL MC LL 20 40 60 80
SHEAR STRENGTH (ksf) 1 2 3 4

30 Bottom of borehole at 30.0 feet.

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Fax: 417-864-6000

KEY TO SYMBOLS

CLIENT Childers Architect
PROJECT NAME W.W. Hastings Replacement Hospital
PROJECT NO. 277340
PROJECT LOCATION Tahlequah, Oklahoma

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

- CH: USCS High Plasticity Clay
- CHERT: Chert
- CHG: USCS High Plasticity Gravelly Clay
- CL: USCS Low Plasticity Clay
- CL-CH: USCS Low to High Plasticity Clay
- CLG: USCS Low Plasticity Gravelly Clay
- CLS: USCS Low Plasticity Sandy Clay
- CONCRETE: Concrete
- GC: USCS Clayey Gravel
- GW: USCS Well-graded Gravel
- LIMESTONE: Limestone
- SC: USCS Clayey Sand
- SHALE: Shale
- TOPSOIL: Topsoil
- VOID: Void
- WEATHERED LIMESTONE: Weathered Limestone

SAMPLER SYMBOLS

- NQ
- Standard Penetration Test
- Shelby Tube

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
W - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
-200 - PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)
TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UC - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION

- Water Level at Time Drilling, or as Shown
- Water Level at End of Drilling, or as Shown
- Water Level After 24 Hours, or as Shown

APPENDIX II

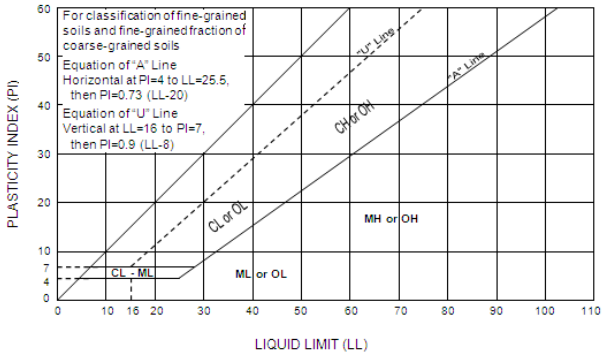
GENERAL NOTES

GENERAL NOTES

SOIL PROPERTIES & DESCRIPTIONS

COHESIVE SOILS

Consistency	Unconfined Compressive Strength (Qu)	Pocket Penetrometer Strength	N-Value
	(psf)	(tsf)	(blows/ft)
Very Soft	<500	<0.25	0-1
Soft	500-1000	0.25-0.50	2-4
Medium Stiff	1001-2000	0.50-1.00	5-8
Stiff	2001-4000	1.00-2.00	9-15
Very Stiff	4001-8000	2.00-4.00	16-30
Hard	>8000	>4.00	31-60
Very Hard			>60



Group Symbol	Group Name
CL –	Lean Clay
ML –	Silt
OL –	Organic Clay or Silt
CH –	Fat Clay
MH –	Elastic Silt
OH –	Organic Clay or Silt
PT –	Peat
CL-CH –	Lean to Fat Clay

Plasticity		Moisture	
Description	Liquid Limit (LL)	Descriptive Term	Guide
Lean	<45%	Dry	No indication of water
Lean to Fat	45-49%	Moist	Indication of water
Fat	≥50%	Wet	Visible water

Fine Grained Soil Subclassification	Percent (by weight) of Total Sample
Terms: SILT, LEAN CLAY, FAT CLAY, ELASTIC SILT	PRIMARY CONSTITUENT
Sandy,gravelly, abundant cobbles, abundant boulders	>30-50]
with sand, with gravel, with cobbles, with boulders	>15-30] – secondary coarse grained constituents
scattered sand, scattered gravel, scattered cobbles, scattered boulders	5-15]
a trace sand, a trace gravel, a few cobbles, a few boulders	<5]
The relationship of clay and silt constituents is based on plasticity and normally determined by performing index tests. Refined classifications are based on Atterberg Limits tests and the Plasticity Chart.	

NON-COHESIVE (GRANULAR) SOILS

RELATIVE DENSITY	N-VALUE
Very Loose	0-4
Loose	5-10
Medium Dense	11-24
Dense	25-50
Very Dense	≥51

MOISTURE CONDITION	
Descriptive Term	Guide
Dry	No indication of water
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table.

**GRAIN SIZE IDENTIFICATION		
Name	Size Limits	Familiar Example
Boulder	12 in. or more	Larger than basketball
Cobbles	3 in. to 12 in.	Grapefruit
Coarse Gravel	¾-in. to 3 in.	Orange or lemon
Fine Gravel	No. 4 sieve to ¾-in.	Grape or pea
Coarse Sand	No. 10 sieve to No. 4 sieve	Rock salt
Medium Sand	No. 40 sieve to No. 10 sieve	Sugar, table salt
Fine Sand*	No. 200 sieve to No. 40 sieve	Powdered sugar
Fines	Less than No. 200 sieve	
*Particles finer than fine sand cannot be discerned with the naked eye at a distance of 8 in.		

Coarse Grained Soil Subclassification	Percent (by weight) of Total Sample
Terms: GRAVEL, SAND, COBBLES, BOULDERS	PRIMARY CONSTITUENT
Sandy,gravelly, abundant cobbles, abundant boulders	>30-50]
with gravel, with sand, with cobbles, with boulders	>15-30] – secondary coarse grained constituents
scattered gravel, scattered sand, scattered cobbles, scattered boulders	5-15]
a trace gravel, a trace sand, a few cobbles, a few boulders	<5]
Silty (MH & ML)*, clayey (CL & CH)*	<15]
(with silt, with clay)*	5-15] – secondary fine grained constituents
(trace silt, trace clay)*	<5]
*Index tests and/or plasticity tests are performed to determine whether the term "silt" or "clay" is used.	

*Modified after Ref. ASTM D2487-93 & D2488-93
**Modified after Ref. Oregon DOT 1987 & FHWA 1997
***Modified after Ref. AASHTO 1988, DM 7.1 1982, and Oregon DOT 1987

GENERAL NOTES

BEDROCK PROPERTIES & DESCRIPTIONS

ROCK QUALITY DESIGNATION (RQD)	
Description of Rock Quality	*RQD (%)
Very Poor	< 25
Poor	25-50
Fair	50-75
Good	75-90
Excellent	90-100

*RQD is defined as the total length of sound core pieces 4 in. or greater in length, expressed as a percentage of the total length cored. RQD provides an indication of the integrity of the rock mass and relative extent of seams and bedding planes.

SCALE OF RELATIVE ROCK HARDNESS		
Term	Field Identification	Approx. Unconfined Compressive Strength (tsf)
Extremely Soft	Can be indented by thumbnail	2.6-10
Very Soft	Can be peeled by pocket knife	10-50
Soft	Can be peeled with difficulty by pocket knife	50-260
Medium Hard	Can be grooved 2 mm deep by firm pressure of knife	260-520
Moderately Hard	Requires one hammer blow to fracture	520-1040
Hard	Can be scratched with knife or pick only with difficulty	1040-2610
Very Hard	Cannot be scratched by knife or sharp pick	>2610

DEGREE OF WEATHERING	
Slightly Weathered	Rock generally fresh, joints stained and discoloration extends into rock up to 25mm (1 in), open joints may contain clay, core rings under hammer impact.
Weathered	Rock mass is decomposed 50% or less, significant portions of rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.
Highly Weathered	Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

GRAIN SIZE (TYPICALLY FOR SEDIMENTARY ROCKS)		
Description	Diameter (mm)	Field Identification
Very Coarse Grained	>4.76	
Coarse Grained	2.0-4.76	Individual grains can easily be distinguished by eye.
Medium Grained	0.42-2.0	Individual grains can be distinguished by eye.
Fine Grained	0.074-0.42	Individual grains can be distinguished by eye with difficulty.
Very Fine Grained	<0.074	Individual grains cannot be distinguished by unaided eye.

VOIDS	
Pit	Voids barely seen with naked eye to 6mm (¼-in)
Vug	Voids 6 to 50mm (¼ to 2 in) in diameter
Cavity	50 to 6000mm (2 to 24 in) in diameter
Cave	>600mm

BEDDING THICKNESS	
Very Thick Bedded	> 3' thick
Thick Bedded	1' to 3' thick
Medium Bedded	4" to 1' thick
Thin Bedded	1¼" to 4" thick
Very Thin Bedded	½" to 1¼" thick
Thickly Laminated	⅛" to ½" thick
Thinly Laminated	⅛" or less (paper thin)

DRILLING NOTES

Drilling and Sampling Symbols

NQ – Rock Core (2-in. diameter)
HQ – Rock Core (3 in. diameter)
HSA – Hollow Stem Auger
CFA – Continuous Flight (Solid Stem) Auger
SS – Split Spoon Sampler
ST – Shelby Tube
WB – Wash Bore or Mud Rotary
TP – Test-Pit
HA – Hand Auger

Soil Sample Types

Shelby Tube Samples: Relatively undisturbed soil samples were obtained from the borings using thin wall (Shelby) tube samplers pushed hydraulically into the soil in advance of drilling. This sampling, which is considered to be undisturbed, was performed in accordance with the requirements of ASTM D 1587. This type of sample is considered best for the testing of "in-situ" soil properties such as natural density and strength characteristics. The use of this sampling method is basically restricted to soil containing little to no chert fragments and to softer shale deposits.

Split Spoon Samples: The Standard Penetration Test is conducted in conjunction with the split-barrel sampling procedure. The "N" value corresponds to the number of blows required to drive the last 1 foot of an 18-in. long, 2-in. O.D. split-barrel sampler with a 140 lb. hammer falling a distance of 30 in. The Standard Penetration Test is carried out according to ASTM D-1586.

Water Level Measurements

Water levels indicated on the boring logs are levels measured in the borings at the times indicated. In permeable materials, the indicated levels may reflect the location of groundwater. In low permeability soils, shallow groundwater may indicate a perched condition. Caution is merited when interpreting short-term water level readings from open bore holes. Accurate water levels are best determined from piezometers.

Automatic Hammer

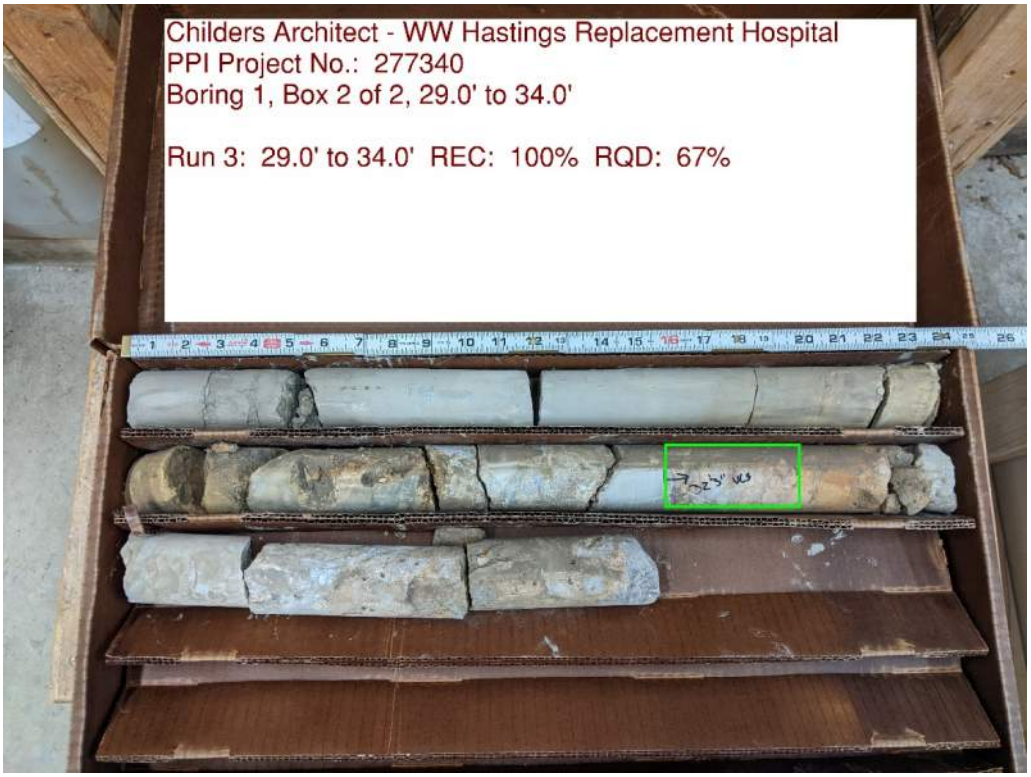
Palmerton and Parrish's CME's are equipped with automatic hammers. The conventional method used to obtain disturbed soil samples used a safety hammer operated by company personnel with a cat head and rope. However, use of an automatic hammer allows a greater mechanical efficiency to be achieved in the field while performing a Standard Penetration resistance test based upon automatic hammer efficiencies calibrated using dynamic testing techniques.

*Modified after Ref. ASTM D2487-93 & D2488-93
**Modified after Ref. Oregon DOT 1987 & FHWA 1997
***Modified after Ref. AASHTO 1988, DM 7.1 1982, and Oregon DOT 1987

APPENDIX III

ROCK CORE PHOTOGRAPHS

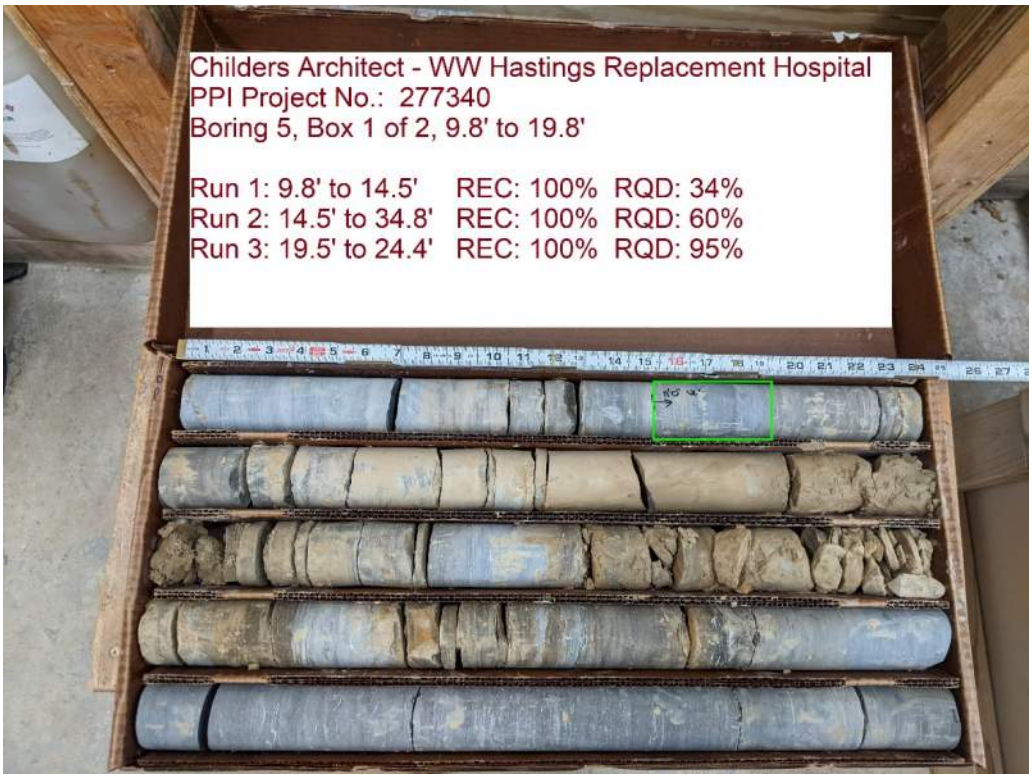

Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 1, Box 1 of 2, Depth: 19.0' to 29.0'
Run 1: 19.0' to 24.0' REC: 80% RQD: 75%
Run 2: 24.0' to 29.0' REC: 100% RQD: 58%
VOID

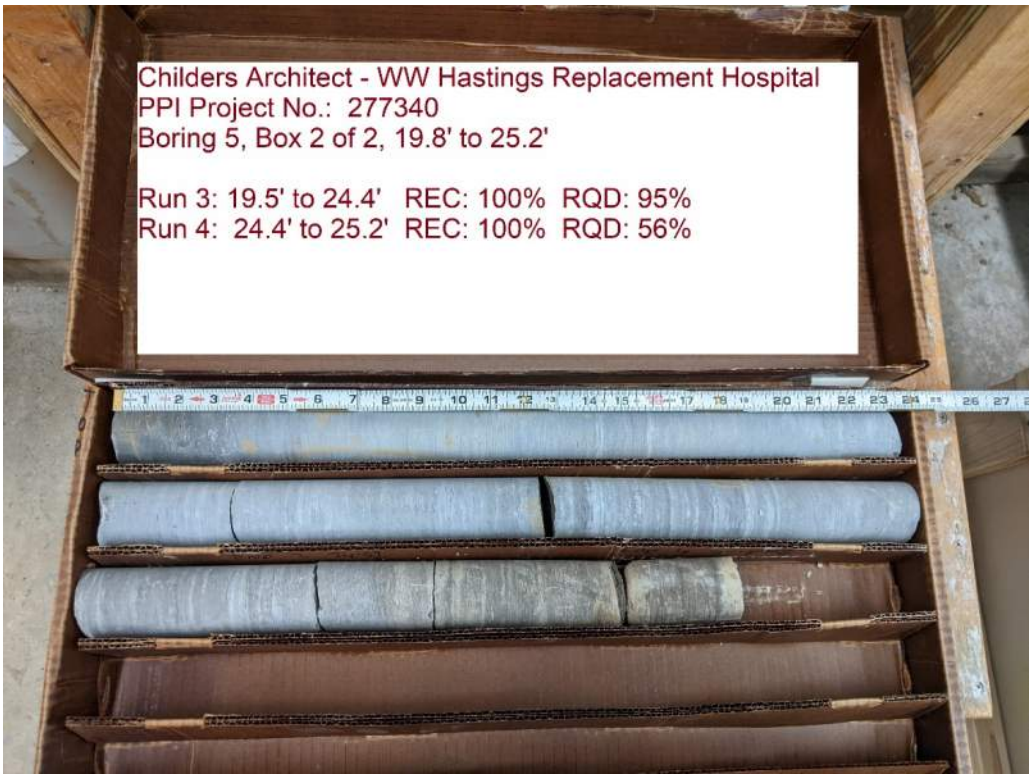

Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 1, Box 2 of 2, 29.0' to 34.0'
Run 3: 29.0' to 34.0' REC: 100% RQD: 67%


Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 2, Box 1 of 1, 21.8' to 24.0'
Run 1: 21.8' to 24.0' REC: 50% RQD: 50%

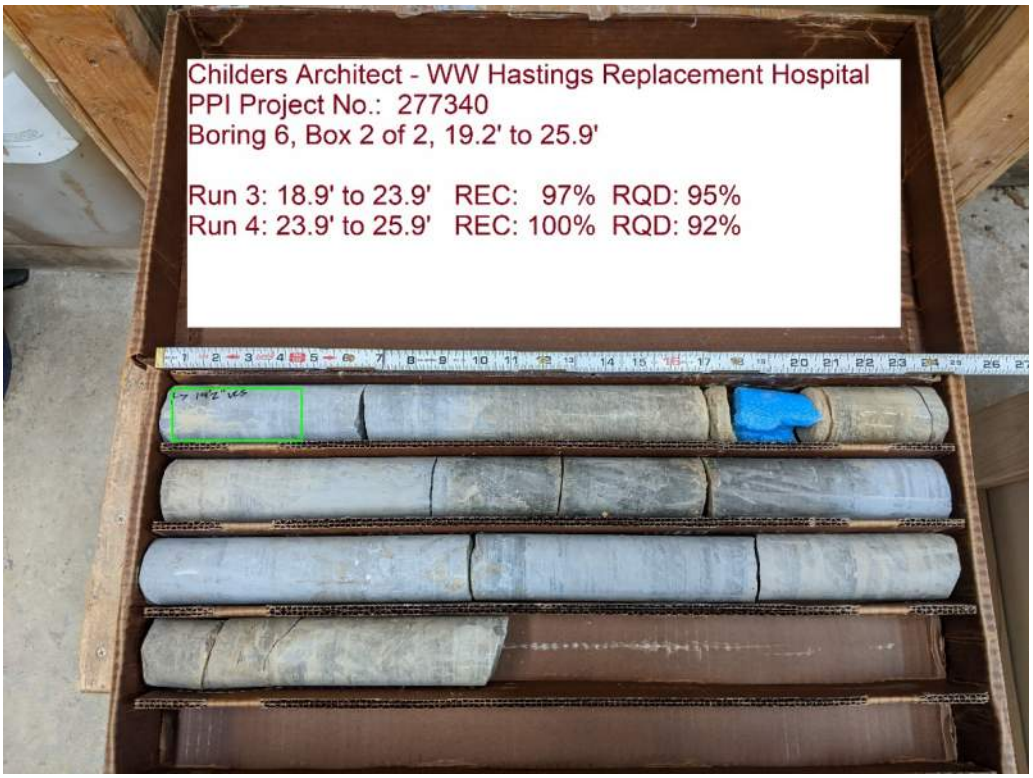

Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 3, Box 1 of 1, 28.5' to 38.3'
Run 1: 28.5' to 29.8' REC: 100% RQD: 100%
Run 2: 29.8' to 34.8' REC: 100% RQD: 72%
Run 3: 34.8' to 38.3' REC: 100% RQD: 40%


Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 4, Box 1 of 1, 25.5' to 35.5'
Run 1: 25.5' to 29.2' REC: 100% RQD: 32%
Run 2: 29.2' to 34.2' REC: 97% RQD: 78%
Run 3: 34.2' to 35.5' REC: 100% RQD: 44%


Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 5, Box 1 of 2, 9.8' to 19.8'
Run 1: 9.8' to 14.5' REC: 100% RQD: 34%
Run 2: 14.5' to 34.8' REC: 100% RQD: 60%
Run 3: 19.5' to 24.4' REC: 100% RQD: 95%


Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 5, Box 2 of 2, 19.8' to 25.2'
Run 3: 19.5' to 24.4' REC: 100% RQD: 95%
Run 4: 24.4' to 25.2' REC: 100% RQD: 56%


Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 6, Box 1 of 2, 9.2' to 19.2'
Run 1: 9.2' to 13.9' REC: 77% RQD: 44%
Run 2: 13.9' to 18.9' REC: 100% RQD: 93%
Run 3: 18.9' to 23.9' REC: 97% RQD: 95%


Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 6, Box 2 of 2, 19.2' to 25.9'
Run 3: 18.9' to 23.9' REC: 97% RQD: 95%
Run 4: 23.9' to 25.9' REC: 100% RQD: 92%


Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 8, Box 1 of 2, 16.2' to 26.2'
Run 1: 16.2' to 18.8' REC: 100% RQD: 97%
Run 2: 18.8' to 23.8' REC: 100% RQD: 98%
Run 3: 23.8' to 28.8' REC: 100% RQD: 58%


Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 8, Box 2 of 2, 26.2' to 31.1'
Run 3: 23.8' to 28.8' REC: 100% RQD: 58%
Run 4: 28.8' to 31.1' REC: 100% RQD: 71%


Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 9, Box 1 of 2, 22.8' to 32.8'
Run 1: 22.8' to 24.1' REC: 100% RQD: 0%
Run 2: 24.1' to 29.1' REC: 52% RQD: 30%
Run 3: 29.1' to 34.1' REC: 65% RQD: 18%


Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 9, Box 2 of 2, 32.8' to 34.1'
Run 3: 29.1' to 34.1' REC: 65% RQD: 18%


Childers Architect - WW Hastings Replacement Hospital
PPI Project No.: 277340
Boring 13, Box 1 of 1, 23.5' to 31.0'
Run 1: 23.5' to 24.0' REC: 100% RQD: 100%
Run 2: 24.0' to 29.0' REC: 100% RQD: 45%
Run 3: 29.0' to 31.0' REC: 83% RQD: 71%

APPENDIX IV

IMPORTANT INFORMATION REGARDING YOUR GEOTECHNICAL REPORT

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled*. No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed*. The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

ADDENDUM NO. 1 - GEOTECHNICAL ENGINEERING REPORT
DATED: 08/18/2022

PALMERTON & PARRISH, INC.

GEOTECHNICAL & MATERIALS ENGINEERS
MATERIALS TESTING LABORATORIES
ENVIRONMENTAL SERVICES

4168 W. Kearney St.
Springfield, MO 65803
Ph: (417) 864-6000
www.ppimo.com

August 18, 2022

Childers Architect
142 Howell Street, Suite 170
Dallas, Texas 75207

Attn: Mr. Matthew Thomas, Associate AIA
Email: mthomas@childersarchitect.com

RE: Geotechnical Engineering Report – Addendum 1
W.W. Hastings Replacement Hospital & Parking Garage
Tahlequah, Oklahoma
PPI Project Number: 277340

Dear Mr. Thomas:

This report addendum No. 1 was prepared to provide additional information for the design of drilled piers at the project site. As stated within Section 9.2.3 and 9.2.4 of the original Geotechnical Engineering Report, dated February 9, 2022, pier pre-drilling was recommended at each drilled pier location to determine specific subsurface conditions at the exact column location. The Design Team has elected to perform pre-drilling. As a result it is recommended that the following items of the original Geotechnical Engineering Report be amended, including:

- **Table 9.2.2 – Minimum Pier Penetration** – The minimum pier penetration for Zone 1 & 2 piers will be dictated by specific column loads and soil conditions determined by PPI, however, the following absolute minimum pier penetration for each are provided below:

    - Zone 1 – Min. 10 ft. below existing ground surface or deeper, although much deeper pier depths are anticipated to be required.
    - Zone 2 – Min. 1 ft. rock socket into competent bedrock consisting of limestone, shale or solid chert. Again, column loads may dictate deeper embedment depths.

- **Table 9.2.2 – Minimum Shaft Diameter** – Minimum pier diameter may be reduced to 24-inches, in lieu of 30-inches as originally published.

Closure

We appreciate this opportunity to be of service and if you have any questions, please don't hesitate to contact this office.

PALMERTON & PARRISH, INC.
By:

Shane M. Rader, P.E.
Geotechnical Engineer

PALMERTON & PARRISH, INC.
By:

Brandon R. Parrish, P.E.
Vice President
08/18/22

Submitted: One (1) Electronic .pdf Copy

BRP/SMR/brp

ADDENDUM NO. 2 - GEOTECHNICAL ENGINEERING REPORT
DATED: 11/09/2022

PALMERTON & PARRISH, INC.

GEOTECHNICAL & MATERIALS ENGINEERS
MATERIALS TESTING LABORATORIES
ENVIRONMENTAL SERVICES

4168 W. Kearney St.
Springfield, MO 65803
Ph: (417) 864-6000
www.ppimo.com

November 9, 2022

Childers Architect
142 Howell Street, Suite 170
Dallas, Texas 75207

Attn: Mr. Matthew Thomas, Associate AIA
Email: mthomas@childersarchitect.com

RE: Geotechnical Engineering Report – Addendum 2
W.W. Hastings Replacement Hospital & Parking Garage
Tahlequah, Oklahoma
PPI Project Number: 277340

Dear Mr. Thomas:

This report addendum No. 2 was prepared to provide additional information for the design of structure foundations at the project site. As stated within Section 9.0 of the original Geotechnical Engineering Report, dated February 9, 2022, only one foundation type per structure was recommended to reduce the potential for differential settlement or structures designed to accommodate some differential settlement between foundation types. Since report submittal, preliminary design of the foundations is understood to have been performed. Preliminary design is understood to utilize drilled piers for the heavy, loads from the multi-story structure and shallow foundations within the single story, lightly loaded area within the northeast of the structure footprint. It is our opinion that due to the very light loads anticipated in the single story area, as well as the relatively stiff soil conditions present at the site, only minimal to negligible differential settlement is anticipated between these two foundation types and using a shallow foundation system to support the single story, very light loads is considered acceptable. This recommendation is only valid at the current bay spacing. Any reduction in bay spacing between deep and shallow foundations should be reviewed by PPI and this Addendum revised, if necessary.

Closure

We appreciate this opportunity to be of service and if you have any questions, please don't hesitate to contact this office.

PALMERTON & PARRISH, INC.
By:

Shane M. Rader, P.E.
Geotechnical Engineer

PALMERTON & PARRISH, INC.
By:

Brandon R. Parrish, P.E.
Vice President

LICENSED PROFESSIONAL ENGINEER
BRANDON ROSS PARRISH
24765
OKLAHOMA
11/09/22

10000 Hwy 160
Walnut Shade, MO 65771
Ph: (417) 561-8395

3500 East 13th Street
Joplin, MO 64801
Ph: (417) 624-2005

DRILLED PIER PRE-DRILLING SUMMARY LETTER
DATED: 11/04/2022

PALMERTON & PARRISH, INC.

GEOTECHNICAL & MATERIALS ENGINEERS
MATERIALS TESTING LABORATORIES
ENVIRONMENTAL SERVICES

4168 W. Kearney Street.
Springfield, MO 65803
Ph: (417) 864-6000
www.ppimo.com

November 4, 2022

Foreman – Manhattan Construction Team
5601 South 122nd East Ave.
Tulsa, OK 74146

Attn: Mr. Patrick Fogarty, Sr. Project Manager
Email: pfogarty@manhattanconstruction.com

RE: Pier Pre-Drill Results Summary Letter
W.W. Hastings Replacement Hospital
17665 S. Muskogee Ave.
Tahlequah, Oklahoma
PPI Project Number: 280212

Dear Mr. Fogarty:

Palmerton and Parrish, Inc. (PPI) appreciates the opportunity to submit this Pier Pre-Drill Summary Letter for the W.W. Hastings Replacement Hospital project located in Tahlequah, Oklahoma. PPI has previously provided a Geotechnical Engineering Report for the proposed Replacement Hospital numbered 277340 and dated February 9, 2022. The purpose of this letter is to provide a summary of the Pier Pre-Drilling Results as well as considerations for the proposed W.W. Hastings Replacement Hospital Foundations. **This is not a stand-alone letter and should be used along with the original geotechnical report noted above.**

Pier Pre-Drilling Summary

Subsurface conditions at the subject site in the locations of the proposed drilled piers were explored through the completion of subsurface borings. Pier locations and elevations were provided by the client and marked in the field by a surveyor. A total of 108 pier pre-drill borings were completed at the subject site.

Borings were drilled between August 30th to October 27, 2022. Borings in soils were generally advanced using a combination of 4.5-inch O.D. continuous flight augers and mud rotary techniques using a 3-inch O.D. tri-cone bit powered by ATV-mounted drill-rigs. Soil samples and SPT blow counts were collected at 5-foot centers during drilling for estimates of soil shear strengths/friction angles. Soil sample types included split spoon samples collected while performing the Standard Penetration Test (SPT) in general accordance with ASTM D1586. These values along with the soil classifications were utilized to estimate allowable loads, skin friction, and lateral loading criteria for the drilled pier at the specific boring location.

When bedrock was encountered, rock coring procedures were implemented. Continuous rock cores were obtained using a NQ2 double tube wireline core barrel with a diamond-impregnated bit. The rock core obtained was placed in core boxes in the order of recovery. Rock core recovery and conditions were observed by PPI's engineers to determine appropriate bearing stratums, allowable loads, skin friction values, and lateral loading conditions of the bedrock for the drilled pier at the specified boring location.

Results of Pier Pre-Drilling

As previously noted, a total of 108 pre-drill borings were performed at the subject site. Results of the pier pre-drilling were evaluated on a weekly basis and provided to the client and design teams. As noted in the Geotechnical Report numbered 277340 and dated February 9, 2022, the site contains zones of deep, cherty clays and zones of solid chert and shallower bedrock materials. Where deep cherty clays were encountered, PPI provided drilled pier parameters for soil bearing conditions. Where bedrock was noted, PPI provided parameters for bedrock bearing conditions. Additionally, if voids were noted in the bedrock or clays, PPI adjusted allowable end bearing and side friction values to account for these voids. Individual drilled pier parameters based on the results of the pier pre-drilling have been attached to this summary letter.

Drilled Pier Considerations

As previously noted above, this letter is not a stand-alone letter and should be used along with the Original Geotechnical Report numbered 277340 and dated February 9, 2022 and with the Addendum Letter dated August 18, 2022. PPI is providing the following additional considerations based on the results of the pier pre-drilling performed at the subject site:

- **Soil and Bedrock Bearing Conditions** – Pier pre-drilling identified zones of deep soils, intermittent solid chert layers, and zones of relatively shallow bedrock materials. Due to the strain incompatibility of soil versus bedrock, borings with intact bedrock were not provided soil skin frictional values. Accordingly, drilled pier design should not assign skin frictional values to soils where bedrock was the primary bearing material. The attached Pier Drilling Summary tables account for this recommendation.

- **Possible Pier Pre-Drilling and Pier Drilling Variation** - PPI's pre-drilling utilized a 2-inch to 4.5-inch diameter exploration boring to evaluate the conditions at the proposed pier location. It is understood that pier diameters may vary from 2.5 feet to 6 feet in diameter. Accordingly, some variability of the drilled pier termination conditions compared to the pre-drill conditions may be encountered across the bottom of the drilled pier area. It is recommended that the drilled pier be observed for any unsuitable conditions including voids or soft soils prior to drilled pier

construction. Drilled piers may have to be deepened if these conditions are encountered. Additionally, a condition of partial bedrock and partial soils may be encountered within some drilled pier end bearings due to the highly variable bedrock pinnacles/elevations encountered. If highly varying pier end bearing conditions are encountered, PPI should be contacted to provide additional recommendations.

- **Significant Construction Difficulty** – As noted in the Original Geotechnical Report, the subsurface materials at the site are oftentimes hard and highly abrasive and considered very resistant to typical auger methods. In any event, the drilled pier contractor should anticipate the use of rock augers, rock core barrels and potentially down the hole hammers with a heavy-duty drill rig in order to excavate the drilled piers to the minimum depths specified. Slow drilling production and heavy bit wear should also be anticipated. **It is highly recommended that the drilled pier contractor selected have the proper equipment and experience with drilling in the nearby area and in these material types.**

- **Concrete Loss Due to Voids** – PPI encountered numerous small voids and loss of circulation areas at the subject site during pier pre-drilling operations. Additionally, a consistent void depth was noted in the southwest corner of the proposed new hospital building that may indicate the presence of a larger void. Significant concrete loss may be possible within this area when drilling through this void. Additionally, concrete over-run related to sloughing or caving of the shaft sidewalls is possible and unit prices should be established for these items in the contract documents.

- **Drilled Pier Load Testing** - An on-site load test of a production drilled pier is not considered a requirement. However, due to the potential for piers to encounter differing end bearing conditions across the width of the drilled pier bearing depth, it is recommended that the contractor bid form include a cost to perform such a load test if conditions encountered within a certain pier necessitate confirmation. Pier load tests, if required, should be performed in accordance with ASTM D1143 and ASTM D3689 for compressive and tensile capacity.

Should you have any questions or need additional information, please feel free to call our office (417-864-6000).

PALMERTON & PARRISH, INC.
By:

R. Todd Hercules, P.E.
Geotechnical Engineer

PALMERTON & PARRISH, INC.
By:

Brandon R. Parrish, P.E.
Vice-President

11/04/2022

Attachments: Pre-Drill Boring Summary Sheets (108 total)

PALMERTON & PARRISH, INC.

4168 W. Kearney St.
Springfield, MO 65803
Ph: (417) 864-6000
www.ppimo.com

Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	1
Grid Line Location:	1-Q
Top Elevation (ft.):	916.1
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	866.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.6	0.5	N.R.	Clay with Intermittent Cherty Clay
2.5 to 17	913.6 to 899.1	0.75	N.R.	
17 to 25	899.1 to 891.1	1.5	20	Clay/Chert Matrix
25 to 29	891.1 to 887.1	1.0	15	Clay with Trace Chert
29 to 33	887.1 to 883.1	1.5	15	Clay/Chert Matrix
33 to 50	883.1 to 866.1	1.5	10	Cherty Clay

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 899.1	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	899.1 to 881.1	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	881.1 to Bottom of Pier	125	2,000	1,000	400	0.005

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	2
Grid Line Location:	Q-2
Top Elevation (ft.):	915.8
Total Depth (ft.):	40
Bottom of Boring Elevation (ft.):	875.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.3	0.75	N.R.	Cherty Clay/Clayey Gravel
2.5 to 20.0	913.3 to 895.8	0.75	N.R.	
20.0 to 23.5	895.8 to 892.3	1.5	30	Chert/Clay Matrix
23.5 to 28.8	892.3 to 887.0	1.5	35	Gravely Clay/Clayey Gravel
28.8 to 40	887.0 to 875.8	1.5	40	Chert/Clay Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 897.3	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	897.3' to Bottom of Pier	125	4,000	2,000	800	0.003

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Springfield, MO 65803
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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	3
Grid Line Location:	Q-3
Top Elevation (ft.):	915.6
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	865.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.1	0.75	N.R.	Clay/Cherty Clay
2.5 to 23	913.1 to 892.6	0.75	N.R.	
23 to 38	892.6 to 877.6	1.5	7.0	
38 to 45	877.6 to 870.6	1.5	12.0	Cherty Clay
45 to 50	870.6 to 865.6	1.5	20	Chert/Clay Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 877.6	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	877.6 to Bottom of Pier	125	4,000	2,000	800	0.003

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Springfield, MO 65803
Ph: (417) 864-6000
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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	4
Grid Line Location:	Q-4
Top Elevation (ft.):	915.6
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	865.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.1	0.75	N.R.	Clay/Cherty Clay
2.5 to 20	913.1 to 895.6	0.75	N.R.	
20 to 28	895.6 to 887.6	1.5	10	Cherty Clay
28 to 50	887.6 to 865.6	1.5	40	Chert/Clay Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 895.6	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	895.6 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	5
Grid Line Location:	Q-5
Top Elevation (ft.):	916
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	866.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.5	0.75	N.R.	Clay/Cherty Clay
2.5 to 23	913.5 to 893.0	0.75	N.R.	
23 to 28	893.0 to 888.0	1.5	N.R.	
28 to 33	888.0 to 883.0	1.5	10	
33 to 40.5	883.0 to 875.5	0.75	N.R.	Clay
40.5 to 50	875.5 to 866	1.5	30	Chert/Clay Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 893.0	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	893.0 to 883.0	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	883.0 to 875.5	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	875.5 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	6
Grid Line Location:	Q-6
Top Elevation (ft.):	916.6
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	866.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.1	0.75	N.R.	Cherty Clay/Clayey Gravel
2.5 to 23	914.1 to 893.6	0.75	N.R.	
23 to 31	893.6 to 885.6	1.5	10	
31 to 44	885.6 to 872.6	1.5	4.0	Clay with Chert
44 to 50	872.6 to 866.6	1.5	30	Chert/Clay Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 893.6	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	893.6 to Bottom of Pier	125	4,000	2,000	800	0.003

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Springfield, MO 65803
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Pre-Drill Boring Summary

Project: Pier Pre-Drill - WW Hastings Replacement Hospital
Client: Foreman Manhattan
Project #: 280212
Pre Drill Boring #: 7
Grid Line Location: Q-6.6
Top Elevation (ft.): 916.8
Total Depth (ft.): 50
Bottom of Boring Elevation (ft.): 866.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.3	0.75	N.R.	Intermittent Clay/Cherty Clay
2.5 to 18.5	914.3 to 898.3	0.75	N.R.	
18.5 to 22	898.3 to 894.8	1.5	25	
22 to 33	894.8 to 883.8	1.5	6.0	
33 to 44	883.8 to 872.8	1.5	3.0	
44 to 50	872.8 to 866.8	1.5	10	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 898.3	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	898.3 to 889.8	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	889.8 to 878.8	125	1,000	500	200	0.010
Stiff Clay Without Free Water	878.8 to Bottom of Pier	125	4,000	2,000	800	0.003

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4168 W. Kearney St.
Springfield, MO 65803
Ph: (417) 864-6000
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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	8
Grid Line Location:	Q-7
Top Elevation (ft.):	917.1
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	867.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.6	0.75	N.R.	Clay/Cherty Clay
2.5 to 18	914.6 to 899.1	0.75	N.R.	
18 to 33	899.1 to 884.1	1.5	5.0	Chert/Clay Matrix
33 to 38	884.1 to 879.1	1.5	10	
38 to 50	879.1 to 867.1	1.5	10	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 899.1	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	899.1 to Bottom of Pier	125	4,000	2,000	800	0.003

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Springfield, MO 65803
Ph: (417) 864-6000
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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	11
Grid Line Location:	P.7-7
Top Elevation (ft.):	917
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	867.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.5	0.75	N.R.	Clay/Cherty Clay
2.5 to 20	914.5 to 897.0	0.75	N.R.	
20 to 33	897.0 to 884.0	1.5	2.0	Cherty Clay
33 to 40	884.0 to 877.0	1.5	15	
40 to 50	877.0 to 867.0	1.5	40	Clay/Chert Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 897.0	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	897.0 to 889.0	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	889.0 to 884.0	125	1,000	500	200	0.010
Stiff Clay Without Free Water	884.0 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	12
Grid Line Location:	P.3-6
Top Elevation (ft.):	916.7
Total Depth (ft.):	50.3
Bottom of Boring Elevation (ft.):	866.4

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.2	0.75	N.R.	Clay/Cherty Clay with Intermittent Chert Layers
2.5 to 19	914.2 to 897.7	0.75	N.R.	
19 to 34	897.7 to 882.7	1.5	7.0	
34 to 50.3	882.7 to 866.4	1.5	20	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
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Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 902.7	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	902.7 to 890.7	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	890.7 to 897.7	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	897.7 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	13
Grid Line Location:	7-P.3
Top Elevation (ft.):	917.1
Total Depth (ft.):	50.3
Bottom of Boring Elevation (ft.):	866.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.6	0.75	N.R.	Clay/Cherty Clay/Weathered Shale
2.5 to 18	914.6 to 899.1	0.75	N.R.	
18 to 25	899.1 to 892.1	1.0	N.R.	
25 to 28	892.1 to 889.1	0	N.R.	Clay and Possible Void (26.5' to 27.5')
28 to 33	889.1 to 884.1	1.5	30	Clay/Chert Matrix
33 to 50	884.1 to 866.8	1.5	10	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 892.1	125	2,000	1,000	400	0.005
Moderately Stiff Clay Without Free Water	892.1 to 889.1	115	500	100	N/A	0.01
Stiff Clay Without Free Water	889.1 to 884.1	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	884.1 to 869.1	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	869.1 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	14
Grid Line Location:	1-P - Offset 2' East Due to Utility
Top Elevation (ft.):	916.6
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	866.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.1	0.75	N.R.	Clean Clay/Cherty Clay Layers
2.5 to 18	914.1 to 898.6	0.75	N.R.	
18 to 26	898.6 to 890.6	1.5	10	Cherty Clay/Chert Layers
26 to 38	890.6 to 878.6	1.0	15	Intermittent Clean Clay and Chert Layers
38 to 50	878.6 to 866.6	1.5	20	Chert and Clayey Gravel Layers

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 901.6	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	901.6 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	15
Grid Line Location:	P-2
Top Elevation (ft.):	916.3
Total Depth (ft.):	47
Bottom of Boring Elevation (ft.):	869.3

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.8	0.75	N.R.	Gravelly Clay/Clayey Gravel
2.5 to 14	913.8 to 902.3	0.75	N.R.	
14 to 16	902.3 to 900.3	0.75	N.R.	Chert, Trace Clay
16 to 27	900.3 to 889.3	0.75	N.R.	Chert/Clay Matrix
27 to 32	889.3 to 884.3	0.75	20	
32 to 38.3	884.3 to 878.0	1.5	40	
38.3 to 47	878.0 to 869.3	1.5	40	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 884.3'	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	884.3' to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	16
Grid Line Location:	P-3
Top Elevation (ft.):	916.1
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	866.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.6	0.75	N.R.	Cherty Clay
2.5 to 19	913.6 to 897.1	0.75	N.R.	
19 to 29.0	897.1 to 887.1	1.5	10	
29.0 to 35.0	887.1 to 881.1	1.5	30	
35.0 to 50	881.1 to 866.1	1.5	25	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 897.1	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	897.1 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	17
Grid Line Location:	P-4 - Extended Depth
Top Elevation (ft.):	915.8
Total Depth (ft.):	71
Bottom of Boring Elevation (ft.):	844.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.3	0.75	N.R.	Clay/Gravelly Clay
2.5 to 19.2	913.3 to 896.6	0.75	N.R.	
19.2 to 25.5	896.6 to 890.3	1.5	40	Chert/Clay Matrix
25.5 to 35.5	890.3 to 880.3	1.5	30	Gravelly Clay/Clayey Gravel
35.5 to 59	880.3 to 856.8	1.5	5.0	Clay/Gravelly Clay
59 to 71	856.8 to 844.8	1.5	40	Chert/Clay Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 896.6	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	896.6 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	18
Grid Line Location:	P-5
Top Elevation (ft.):	916.1
Total Depth (ft.):	36
Bottom of Boring Elevation (ft.):	880.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.6	0.75	N.R.	Clay/Cherty Clay
2.5 to 17	913.6 to 899.1	0.75	N.R.	
17 to 25	899.1 to 891.1	1.5	35	Chert/Clay Matrix
25 to 36	891.1 to 880.1	1.5	40	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 899.1	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	899.1 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	19
Grid Line Location:	P-6
Top Elevation (ft.):	916.7
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	866.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.2	0.75	N.R.	Clay/Cherty Clay with Intermittent Chert Layers
2.5 to 28	914.2 to 888.7	1.0	N.R.	
28 to 39	888.7 to 877.7	1.5	10	
39 to 50	877.7 to 866.7	1.5	25	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 888.7	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	888.7 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	23
Grid Line Location:	1-N - Offset 1.5' East Due to Utility
Top Elevation (ft.):	917.1
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	867.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.6	0.5	N.R.	Clay/Cherty Clay
2.5 to 20	914.6 to 897.1	0.75	N.R.	
20 to 34	897.1 to 883.1	1.5	10	Clay/Chert Matrix
34 to 39	883.1 to 878.1	1.5	30	
39 to 50	878.1 to 867.1	1.5	40	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 902.6	125	1,000	500	200	0.010
Moderately Stiff Clay Without Free Water	902.6 to 897.1	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	897.1 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	24
Grid Line Location:	2-N
Top Elevation (ft.):	916.7
Total Depth (ft.):	50.5
Bottom of Boring Elevation (ft.):	866.2

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.2	0.5	N.R.	Cherty Clay With Intermittent Clean Clay Layers
2.5 to 20	914.2 to 896.7	0.75	N.R.	
20 to 40	896.7 to 876.7	1.5	15	Clay/Chert Matrix
40 to 50.5	876.7 to 866.2	1.5	30	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Moderately Stiff Clay Without Free Water	1 Pier Diameter to 900.2	115	1,000	500	200	0.010
Stiff Clay Without Free Water	900.2 to to Bottom of Pier	115	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	25
Grid Line Location:	3-N
Top Elevation (ft.):	916.5
Total Depth (ft.):	50.9
Bottom of Boring Elevation (ft.):	865.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.0	0.75	N.R.	Clean Clay with chert Lenses
2.5 to 19	914.0 to 897.5	0.75	N.R.	
19 to 26	897.5 to 890.5	1.5	2.5	
26 to 32	890.5 to 884.5	1.0	2.5	
32 to 35	884.5 to 881.5	1.5	40	Clay/Chert Matrix
35 to 50	881.5 to 865.6	1.5	20	Cherty Clay

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 884.5	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	884.5 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	26
Grid Line Location:	4-N - Offset 4' East Due to Utilitiy - Extended Depth
Top Elevation (ft.):	916.1
Total Depth (ft.):	70
Bottom of Boring Elevation (ft.):	846.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.6	0.75	N.R.	Clay With Some Cherty Clay
2.5 to 19	913.6 to 897.1	0.75	N.R.	
19 to 23	897.1 to 893.1	1.5	20	Cherty Clay
23 to 36	893.1 to 880.1	1.5	10	
36 to 62	880.1 to 854.1	1.5	4	Clay with Intermittent Chert Layers
62 to 70	854.1 to 846.1	1.5	30	Chert

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 905.1	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	905.1 to 880.1	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	880.1 to 854.1	125	1,000	500	200	0.010
Stiff Clay Without Free Water	854.1 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	27
Grid Line Location:	5-N
Top Elevation (ft.):	916.3
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	866.3

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.8	0.75	N.R.	Clay With Chert
2.5 to 14	913.8 to 902.3	0.75	N.R.	
14 to 20	902.3 to 896.3	1.5	20	Clay/Chert Matrix
20 to 25	896.3 to 891.3	1.5	40	
25 to 41	891.3 to 875.3	1.5	20	Cherty Clay
41 to 50	875.3 to 866.3	1.5	40	Clay/Chert Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 902.3	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	902.3 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	28
Grid Line Location:	N-6 - Extended Depth
Top Elevation (ft.):	916.8
Total Depth (ft.):	70
Bottom of Boring Elevation (ft.):	846.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.3	0.75	N.R.	Clay/Cherty Clay
2.5 to 20	914.3 to 896.8	0.75	N.R.	
20 to 25	896.8 to 891.8	1.5	40	Intermittent Cherty Clay and Chert/Clay Matrix
25 to 46	891.8 to 870.8	1.25	7.0	Intermittent Clay & Cherty Clay
46 to 63	870.8 to 853.8	1.25	4.0	
63 to 70	853.8 to 846.8	1.5	20	Chert

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 896.8	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	896.8 to 883.8	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	883.8 to 876.8	125	1,000	500	200	0.010
Stiff Clay Without Free Water	876.8 to 865.8	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	865.8 to 853.8	125	1,000	500	200	0.010
Stiff Clay Without Free Water	853.8 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	36
Grid Line Location:	1-L - 2' Offset East Due to Utility
Top Elevation (ft.):	917
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	867.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.5	0.5	N.R.	Clay/Cherty Clay
2.5 to 20	914.5 to 897.0	0.5	N.R.	
20 to 40	897.0 to 877.0	1.5	30	Chert/Cherty Clay
40 to 50	877.0 to 867.0	1.5	40	Clay/Chert Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 897.0	125	1,000	500	200	0.010
Stiff Clay Without Free Water	897.0 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	37
Grid Line Location:	2-L
Top Elevation (ft.):	916.7
Total Depth (ft.):	61
Bottom of Boring Elevation (ft.):	855.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.2	0.5	N.R.	Clay
2.5 to 23	914.2 to 893.7	0.5	N.R.	
23 to 27	893.7 to 889.7	1.5	30	Chert with Clay Layers
27 to 39	889.7 to 877.7	1.5	20	
39 to 54	877.7 to 862.7	1.5	12	Cherty Clay
54 to 61	862.7 to 855.7	1.5	30	Chert with Clay Layers

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 893.7	125	1,000	500	200	0.010
Stiff Clay Without Free Water	893.7 to 877.7	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	893.7 to 862.7	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	862.7 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	38
Grid Line Location:	3-L - Extended Depth
Top Elevation (ft.):	916.5
Total Depth (ft.):	51.5
Bottom of Boring Elevation (ft.):	865.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.0	0.5	N.R.	Clay/Cherty Clay
2.5 to 17	914.0 to 899.5	0.5	N.R.	
17 to 30	899.5 to 886.5	1.0	N.R.	Cherty Clay With Soft Clay Layers
30 to 36	886.5 to 875.5	1.5	15	Cherty Clay
36 to 44	875.5 to 872.5	0.5	N.R.	Chert/Clay to 41' Clean Clay Below 41'
44 to 59	872.5 to 857.5	1.5	5.0	Clay/Chert Alternating Layers
59 to 75	857.5 to 841.5	1.5	40	Chert/Clay Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 886.5	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	886.5 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	39
Grid Line Location:	4-L
Top Elevation (ft.):	916
Total Depth (ft.):	51
Bottom of Boring Elevation (ft.):	865.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.5	0.5	N.R.	Clay
2.5 to 17	913.5 to 899.0	0.5	N.R.	
17 to 22	899.0 to 894.0	1.5	40	Clay/Chert Matrix
22 to 38	894.0 to 878.0	1.5	10	Clay/Chert Matrix With Intermittent Clean Clay
38 to 43	878.0 to 873.0	1.5	20	
43 to 51	873.0 to 865.0	1.5	15	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Moderately Stiff Clay Without Free Water	1 Pier Diameter to 899.0	115	500	100	N/A	0.010
Stiff Clay Without Free Water	899.0 to 868.0	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	868.0 to Bottom of Pier	125	2,000	1,000	400	0.005

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Pre-Drill Boring Summary

Project: Pier Pre-Drill - WW Hastings Replacement Hospital
Client: Foreman Manhattan
Project #: 280212
Pre Drill Boring #: 40
Grid Line Location: 5-L
Top Elevation (ft.): 916
Total Depth (ft.): 50
Bottom of Boring Elevation (ft.): 866.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.5	0.5	N.R.	Gravelly Clay to 8' Clean Clay Below 8'
2.5 to 15	913.5 to 901.0	0.5	N.R.	
15 to 23	901.0 to 893.0	0	N.R.	
23 to 33	893.0 to 883.0	1.5	20	Clay/Chert Matrix
33 to 44	883.0 to 872.0	1.5	5.0	Chert/Clay to 39' Clean Clay below 39'
44 to 50	872.0 to 866.0	1.5	15	Chert/Cherty Clay

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Moderately Stiff Clay Without Free Water	1 Pier Diameter to 901.0	125	1,000	500	200	0.010
Soft Clay	901.0 to 893.0	100	50	N/A	N/A	0.020
Stiff Clay Without Free Water	893.0 to 881.0	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	881.0 to Bottom of Pier	125	2,000	1,000	400	0.005

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Pre-Drill Boring Summary

Project: Pier Pre-Drill - WW Hastings Replacement Hospital
Client: Foreman Manhattan
Project #: 280212
Pre Drill Boring #: 41
Grid Line Location: 6-L
Top Elevation (ft.): 916.6
Total Depth (ft.): 50
Bottom of Boring Elevation (ft.): 866.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.1	0.75	N.R.	Cherty Clay with Intermittent Layers of Clean Clay
2.5 to 20	914.1 to 896.6	0.75	N.R.	
20 to 23	896.6 to 893.6	1.5	20	
23 to 38	893.6 to 878.6	1.0	2.5	
38 to 44	878.6 to 872.6	1.5	10	Cherty Clay
44 to 50	872.6 to 866.6	1.5	20	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 898.6	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	898.6 to 887.6	125	4,000	2,000	800	0.003
Moderately Stif Clay Without Free Water	887.6 to 873.6	115	500	100	N/A	0.010
Stiff Clay Without Free Water	873.6 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	47
Grid Line Location:	1-K - Offset 2' East Due to Utility - Extended Depth
Top Elevation (ft.):	916.9
Total Depth (ft.):	60
Bottom of Boring Elevation (ft.):	856.9

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.4	0.5	N.R.	Clay/Cherty Clay
2.5 to 31	914.4 to 885.9	0.5	N.R.	
31 to 46.5	885.9 to 870.4	1.5	10	Cherty Clay
46.5 to 60	870.4 to 866.9	1.5	40	Clay/Chert Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 897.9	125	1,000	500	200	0.010
Stiff Clay Without Free Water	897.9 to 869.9	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	869.9 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	48
Grid Line Location:	2-K
Top Elevation (ft.):	916.6
Total Depth (ft.):	80
Bottom of Boring Elevation (ft.):	836.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.1	0.5	N.R.	Clay/Cherty Clay with Possible Small Voids
2.5 to 23	914.1 to 893.6	0.5	N.R.	
23 to 31	893.6 to 885.6	0.75	2.0	Cherty Clay with Chert Layers
31 to 64	885.6 to 852.6	1.5	7.0	
64 to 80	852.6 to 836.6	1.5	40	Chert

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 852.6	125	1,000	500	200	0.010
Stiff Clay Without Free Water	852.6 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	49
Grid Line Location:	3-K
Top Elevation (ft.):	916.4
Total Depth (ft.):	60
Bottom of Boring Elevation (ft.):	856.4

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.9	0.5	N.R.	Clay/Cherty Clay/Thin Shale
2.5 to 17.5	913.9 to 898.9	0.75	N.R.	
17.5 to 21.5	898.9 to 894.9	2.0	N.R.	Cherty Limestone
21.5 to 22.3	894.9 to 894.1	0	N.R.	Possible Void
22.3 to 42	894.1 to 874.4	1.5	5.0	Cherty Clay
42 to 60	874.4 to 856.4	1.5	40	Chert with Intermittent Clay Seams

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Soft Clay	1 Pier Diameter to 906.9	100	500	30	N/A	0.010
Stiff Clay Without Free Water	906.9 to 874.4	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	874.4 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	50
Grid Line Location:	4-K
Top Elevation (ft.):	916
Total Depth (ft.):	62
Bottom of Boring Elevation (ft.):	854.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.5	0.5	N.R.	Clay/Cherty Clay
2.5 to 16	913.5 to 900.0	0.5	N.R.	
16 to 17	**900.0 to 899.0**	**1.5****	N.R.	Shale
17 to 23	**899.0 to 893.0**	**2.0****	**50****	Cherty Limestone
23 to 33	893.0 to 883.0	1.5	N.R.	
33 to 37.5	883.0 to 878.5	1.0	N.R.	Chert & Clay Matrix
37.5 to 42.5	878.5 to 873.5	0	N.R.	6" Void at 38' - Cherty Clay
42.5 to 62	873.5 to 854.0	1.5	10	Clay/Chert Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

** - If the pier bears within this material, the pier should be considered bearing on bedrock and soil skin friction should not be utilized from layers other than shale and cherty limestone.

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 900.0	125	1,000	500	200	0.010
Weathered Limestone/Strong Rock	900.0 to 883.0	150	**Unconfined Compressive Strength (psi)**			
			2,000			
Void	883.0 to 878.0	0	**Cohesion (psf)**	**Static K_h (pci)**	**Cyclic K_h (pci)**	**e_{50}**
			N/A			
Soft Clay	878.0 to 873.5	90	100	30	N/A	0.02
Stiff Clay Without Free Water	873.5 to 854.0	125	2000	1000	400	0.005

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	51
Grid Line Location:	5-K - Extended Depth
Top Elevation (ft.):	915.9
Total Depth (ft.):	60.3
Bottom of Boring Elevation (ft.):	855.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.4	0.5	N.R.	Clay
2.5 to 18.5	913.4 to 897.4	1.0	N.R.	
18.5 to 22.0	897.4 to 893.9	3.0	50	Shale/Cherty Limestone
22.0 to 28.5	893.9 to 887.4	3.0	N.R.	Cherty Limestone
28.5 to 46	887.4 to 869.9	1.0	N.R.	Intermittent Clay and Chert
46 to 60.3	869.9 to 864.9	2.0	50	Fractured Chert

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 898.4	125	1,000	500	200	0.010
Stiff Clay Without Free Water	898.4 to 887.4	150	4,000	2,000	800	0.003
Stiff Clay Without Free Water	887.4 to 869.9	125	1,000	500	200	0.010
Stiff Clay Without Free Water	Below 869.9	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	52
Grid Line Location:	6-K
Top Elevation (ft.):	916.3
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	866.3

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.8	0.5	N.R.	Fat Clay
2.5 to 21	913.8 to 895.3	0.5	N.R.	
21 to 26	895.3 to 890.3	0.75	N.R.	
26 to 38	890.3 to 878.3	1.5	7.0	Cherty Clay
38 to 50	878.3 to 866.3	1.5	40	Chert

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 878.3	125	1,000	500	200	0.010
Stiff Clay Without Free Water	878.3 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	61
Grid Line Location:	1-J Offset 2' East Due to Utility
Top Elevation (ft.):	916.8
Total Depth (ft.):	70
Bottom of Boring Elevation (ft.):	846.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.3	0.3	N.R.	Clay/Cherty Clay
2.5 to 21.5	914.3 to 895.3	0.5	N.R.	
21.5 to 41	895.3 to 875.8	1.5	5	Cherty Clay
41 to 48	875.8 to 861.8	1.5	25	Cherty Clay/Chert
48 to 61	861.8 to 855.8	1.5	1.0	
61 to 70	855.8 to 846.8	1.5	40	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 889.3	125	1,000	500	200	0.010
Stiff Clay Without Free Water	889.3 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	62
Grid Line Location:	2-J
Top Elevation (ft.):	916.5
Total Depth (ft.):	75
Bottom of Boring Elevation (ft.):	841.5

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.0	0.5	N.R.	Clay/Cherty Clay
2.5 to 22	914.0 to 894.5	0.5	N.R.	
22 to 48	894.5 to 868.5	1.5	6.0	Chert With Soft Clay Layers
48 to 53.5	868.5 to 863.0	1.5	12	Chert/Cherty Clay
53.5 to 69	863.0 to 847.5	1.5	7.0	Chert With Soft Clay Layers
69 to 75	847.5 to 841.5	1.5	20	Chert/Cherty Clay

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 894.5	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	894.5 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	63
Grid Line Location:	3-J
Top Elevation (ft.):	916.2
Total Depth (ft.):	54
Bottom of Boring Elevation (ft.):	862.2

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.7	N.R.	N.R.	Clay
2.5 to 14.0	913.7 to 902.2	N.R.	N.R.	
14.0 to 24.0	902.2 to 892.2	1.5	N.R.	Shale
24.0 to 38.0	892.2 to 878.2	3.5	60	Weathered Cherty Limestone
38.0 to 45.5	878.2 to 870.7	3.5	N.R.	
45.5 to 48.5	870.7 to 867.7	1.5	N.R.	Highly Weathered Cherty Limestone
48.5 to 54.0	867.7 to 862.2	1.5	N.R.	Intermittent Voids and Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 902.2	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	902.2 to 892.2	135	4,000	2,000	800	0.003
Cherty Limestone/ Strong Rock	892.2 to 867.7	140	Unconfined Compressive Strength (psi)			
			2,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	64
Grid Line Location:	4-J
Top Elevation (ft.):	915.7
Total Depth (ft.):	34.3
Bottom of Boring Elevation (ft.):	881.4

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.2	N.R.	N.R.	Clay
2.5 to 15.5	913.2 to 900.2	N.R.	N.R.	
15.5 to 25.0	900.2 to 890.7	4.0	20	Shale and Shaley Limestone
25.0 to 28.0	890.7 to 887.7	3.5	20	Weathered Shaley Limestone
28.0 to 34.3	887.7 to 881.4	5.0	100	Cherty Limestone With

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 900.2	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	900.2 to 887.7	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty Limestone/ Strong Rock	887.7 to Bottom of Pier	150	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	65
Grid Line Location:	5-J
Top Elevation (ft.):	916.8
Total Depth (ft.):	38.5
Bottom of Boring Elevation (ft.):	878.3

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.3	N.R.	N.R.	Clay/Cherty Clay
2.5 to 16.3	914.3 to 900.5	N.R.	N.R.	
16.3 to 18	900.5 to 898.8	2.5	60	Shaley Limestone
18 to 29	898.8 to 887.8	1.5	N.R.	Shaley Limestone to Weathered Shale at 25'
29 to 38.5	887.8 to 878.3	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 900.5	125	1,000	500	200	0.010
Shaley Limestone/ Strong Rock	900.5 to 891.8	140	Unconfined Compressive Strength (psi)			
			2,000			
Weathered Shale/ Stiff Clay	891.8 to 888.8	125	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
			4,000	2,000	800	0.003
Cherty Limestone/ Strong Rock	Below 888.8	150	Unconfined Compressive Strength (psi)			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	66
Grid Line Location:	6-J
Top Elevation (ft.):	916.1
Total Depth (ft.):	60
Bottom of Boring Elevation (ft.):	856.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.6	0.5	N.R.	Clay/Cherty Clay
2.5 to 19	913.6 to 897.1	0.75	N.R.	
19 to 28	897.1 to 888.1	1.5	N.R.	Shaley Limestone With Clay Seams 3" Void at 26.1'
28 to 42	888.1 to 874.1	1.5	5	Clay/Chert
42 to 60	874.1 to 856.1	1.5	20	Chert with Clay Seams

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 897.1	125	1,000	500	200	0.010
Stiff Clay Without Free Water	897.1 to 884.1	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	884.1 to 874.1	125	1,000	500	200	0.010
Stiff Clay Without Free Water	874.1 to Bottom of Pier	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	73
Grid Line Location:	1-H
Top Elevation (ft.):	916.9
Total Depth (ft.):	75
Bottom of Boring Elevation (ft.):	841.9

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.4	0.5	N.R.	Cherty Clay
2.5 to 18.5	914.4 to 898.4	0.75	N.R.	
18.5 to 48	898.4 to 868.9	1.5	20	Clay/Chert
48 to 68	868.9 to 848.9	1.5	15	Cherty Clay
68 to 75	848.9 to 841.9	1.5	20	

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 898.4	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	898.4 to 859.9	125	4,000	2,000	800	0.003
Stiff Clay Without Free Water	859.9 to 849.9	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	Below 849.9	125	4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	74
Grid Line Location:	2-H
Top Elevation (ft.):	916.4
Total Depth (ft.):	41.75
Bottom of Boring Elevation (ft.):	874.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.9	N.R.	N.R.	Clay/Cherty Clay/Shaley Clay
2.5 to 25.5	913.9 to 890.9	N.R.	N.R.	
25.5 to 41.75	890.9 to 874.7	2.5	50	Highly Fractured Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 890.9	125	2,000	1,000	400	0.005
Weathered Limestone/Strong Rock	890.9 to	135	Unconfined Compressive Strength (psi)			
			2,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	75
Grid Line Location:	3-H
Top Elevation (ft.):	916.1
Total Depth (ft.):	42.5
Bottom of Boring Elevation (ft.):	873.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.6	N.R.	N.R.	Overburden
2.5 to 16	913.6 to 900.1	N.R.	N.R.	
16 to 25.3	900.1 to 890.8	2.0	N.R.	Weathered Cherty Limestone
25.3 to 27.5	890.8 to 888.6	5.0	100	Cherty Limestone
27.5 to 36	888.6 to 880.1	2.0	N.R.	Weathered Cherty Limestone
36 to 42.5	880.1 to 873.6	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 900.1	125	1,000	500	200	0.010
Weathered Limestone/Strong Rock	900.1 to 890.8	140	Unconfined Compressive Strength (psi)			
			2,000			
Limestone/Strong Rock	890.8 to 888.6		4,000			
Weathered Limestone/Strong Rock	888.6 to 880.1	150	2,000			
	880.1 to Bottom of Pier	150	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	76
Grid Line Location:	4-H
Top Elevation (ft.):	915.6
Total Depth (ft.):	44.8
Bottom of Boring Elevation (ft.):	870.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.1	N.R.	N.R.	Overburden
2.5 to 14	913.1 to 901.6	N.R.	N.R.	
14 to 29.5	901.6 to 886.1	1.5	N.A.	Weathered Cherty Limestone
Below 29.5	Below 886.1	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 901.6	115	500	100	N/A	0.020
Weathered Limestone/Strong Rock	901.6 to 886.1	140	Unconfined Compressive Strength (psi)			
			2,000			
Limestone/Strong Rock	886.1 to Bottom of Pier	150	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	77
Grid Line Location:	5-H
Top Elevation (ft.):	915.6
Total Depth (ft.):	43.3
Bottom of Boring Elevation (ft.):	872.3

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.1	N.R.	N.R.	Overburden
2.5 to 14.6	913.1 to 901.0	N.R.	N.R.	
14.6 to 31	901.0 to 884.6	1.5	N.A.	Weathered Cherty Limestone
Below 31	Below 884.6	5.0	100	Cherty Limestone/Conglomerate

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 901.0	115	500	100	N/A	0.020
Weathered Limestone/Strong Rock	901.0 to 884.6	140	Unconfined Compressive Strength (psi)			
			2,000			
Limestone/Strong Rock	884.6 to Bottom of Pier	150	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	78
Grid Line Location:	6-H
Top Elevation (ft.):	915.9
Total Depth (ft.):	35.3
Bottom of Boring Elevation (ft.):	880.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.1	N.R.	N.R.	Overburden
2.5 to 9.6	913.4 to 906.3	N.R.	N.R.	
9.6 to 22	906.3 to 893.9	1.5	N.R.	Weathered Cherty Limestone
Below 22	Below 893.9	5.0	100	Cherty Limestone/Conglomerate

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 906.3	125	4,000	2,000	800	0.003
Weathered Limestone/Strong Rock	906.3 to 895.0	140	Unconfined Compressive Strength (psi)			
			2,000			
Limestone/Strong Rock	895.0 to Bottom of Pier	150	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	83
Grid Line Location:	1-G
Top Elevation (ft.):	916.7
Total Depth (ft.):	68.1
Bottom of Boring Elevation (ft.):	848.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.2	0.3	N.R.	Cherty Clay/Clay
2.5 to 22.0	914.2 to 894.7	0.5	N.R.	
22.0 to 32.0	894.7 to 884.7	1.5	N.R.	Shale/Chert
32.0 to 35.0	884.7 to 881.7	0	N.R.	VOID
35.0 to 44.0	881.7 to 872.7	0.5	N.R.	Cherty Clay/Chert
44.0 to 51.0	872.7 to 865.7	1.5	2.0	
51.0 to 60.0	865.7 to 856.7	1.5	12.0	
60.0 to 68.1	856.7 to 848.6	1.5	40.0	Chert

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 904.7	125	2,000	1,000	400	0.010
Soft Clay	904.7 to 894.7	115	500	100	N/A	0.020
Stiff Clay Without Free Water	894.7 to 884.7	125	4,000	2,000	800	0.005
Soft Clay	884.7 to 872.7	115	250	30	N/A	0.020
Stiff Clay Without Free Water	872.7 to Bottom of Pier	125	4,000	2,000	800	0.005

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	84
Grid Line Location:	2-G
Top Elevation (ft.):	916.3
Total Depth (ft.):	39.2
Bottom of Boring Elevation (ft.):	877.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.8	N.R.	N.R.	Cherty Clay/Clay
2.5 to 14.0	913.8 to 902.3	N.R.	N.R.	
14.0 to 24.0	902.3 to 892.3	2.5	N.R.	Shaley Limestone With Wash Away Material
24.0 to 39.2	892.3 to 877.1	3.5	60	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 902.3	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	902.3 to Bottom of Pier	135	Unconfined Compressive Strength (psi)			
			2,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	85
Grid Line Location:	3-G
Top Elevation (ft.):	915.9
Total Depth (ft.):	34.1
Bottom of Boring Elevation (ft.):	881.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.4	N.R.	N.R.	Clay/Weathered Shale
2.5 to 14.5	913.4 to 901.4	N.R.	N.R.	
14.5 to 27.0	901.4 to 888.9	4.0	100	Shaley Limestone
27.0 to 34.1	888.9 to 881.8	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 900.2	125	1,000	500	200	0.010
Shaley & Cherty Limestone/ Strong Rock	900.2 to 887.7	145	Unconfined Compressive Strength (psi)			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	86
Grid Line Location:	4-G
Top Elevation (ft.):	915.3
Total Depth (ft.):	46.8
Bottom of Boring Elevation (ft.):	868.5

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.8	N.R.	N.R.	Clay
2.5 to 26.0	912.8 to 889.3	N.R.	N.R.	
26.0 to 35.0	889.3 to 880.3	3.5	40	Shaley Limestone
35.0 to 47.8	880.3 to 868.5	5	100	Limestone With Chert

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Soft Clay	1 Pier Diameter to 889.3	125	500	150	N/A	0.010
Shaley Limestone and Shale/ Strong Rock	889.3 to 880.3	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty Limestone/ Strong Rock	880.3 to Bottom of Pier	150	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	87
Grid Line Location:	5-G
Top Elevation (ft.):	915.3
Total Depth (ft.):	36.8
Bottom of Boring Elevation (ft.):	878.5

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.8	N.R.	N.R.	Clay
2.5 to 11.7	912.8 to 903.6	N.R.	N.R.	
11.7 to 13	903.6 to 902.3	1.5	N.R.	Weathered Shale
13.0 to 18.0	902.3 to 897.3	3.5	50	Shaley Limestone and Weathered Shale
18.0 to 21.5	897.3 to 893.8	3.5	N.R.	
21.5 to 22.5	893.8 to 892.8	0	N.R.	Void
22.5 to 26.0	892.8 to 889.3	3.0	50	Shaley Limestone & Shale
26.0 to 36.8	889.3 to 878.5	3.0	50	Cherty Limestone With Clay Seams

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 903.6	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	903.6 to 883.8	140	Unconfined Compressive Strength (psi)			
			2,000			
Cherty Limestone/ Strong Rock	883.8 to Bottom of Pier	140	2,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	88
Grid Line Location:	6-G
Top Elevation (ft.):	915.4
Total Depth (ft.):	33
Bottom of Boring Elevation (ft.):	882.4

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.9	N.R.	N.R.	Clay
2.5 to 16.0	912.9 to 899.4	N.R.	N.R.	
16.0 to 18.0	899.4 to 897.4	2.0	N.R.	Shale
18.0 to 25.0	897.4 to 890.4	5.0	100	Shaley Limestone
25.0 to 33	890.4 to 882.4	5.0	20	Limestone to Weathered Shale at 32'

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 899.4	125	1,000	500	200	0.010
Shaley Limestone/ Strong Rock	899.4 to 883.4	150	Unconfined Compressive Strength (psi)			
			4,000			
Stiff Clay Without Free Water	Below 883.4	130	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
			4,000	2,000	800	0.003

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	94
Grid Line Location:	1-F
Top Elevation (ft.):	916.7
Total Depth (ft.):	50
Bottom of Boring Elevation (ft.):	866.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.2	N.R.	N.R.	Cherty Clay/Clay
2.5 to 23.0	914.2 to 893.7	N.R.	N.R.	
23.0 to 32.0	893.7 to 884.7	2.5	40	Shale/Chert
32.0 to 50.0	884.7 to 866.7	2.5	50	Cherty Limestone With Thin Weathered Zones

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 897.9	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	897.9 to Bottom of Pier	135	Unconfined Compressive Strength (psi)			
			2,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	95
Grid Line Location:	2-F
Top Elevation (ft.):	916.1
Total Depth (ft.):	61.3
Bottom of Boring Elevation (ft.):	854.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.6	N.R.	N.R.	Clay
2.5 to 27.5	913.6 to 888.6	N.R.	N.R.	
27.5 to 35.5	888.6 to 880.6	3.5	60	Cherty Limestone
35.5 to 42.5	880.6 to 873.6	3.5	N.R.	
42.5 to 47	873.6 to 869.1	1.5	N.R.	Possible Voids and Cherty Limestone
47 to 50.9	869.1 to 865.2	3.5	60	Cherty Limestone
50.9 to 56.5	865.2 to 859.6	3.5	N.R.	
56.5 to 58.5	859.6 to 857.6	N.R.	N.R.	Wash Away Material/No Recovery
58.5 to 60.9	857.6 to 854.8	3.5	60	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 888.6	125	500	150	N/A	0.020
Cherty Limestone/ Strong Rock	888.6 to Bottom of Pier	140	Unconfined Compressive Strength (psi)			
			2,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	96
Grid Line Location:	3-F
Top Elevation (ft.):	915.9
Total Depth (ft.):	42.4
Bottom of Boring Elevation (ft.):	873.5

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.4	N.R.	N.R.	Clay
2.5 to 13.5	913.4 to 902.4	N.R.	N.R.	
13.5 to 16.5	902.4 to 899.4	3.5	40	Shaley Limestone
16.5 to 23.0	899.4 to 892.9	3.5	N.R.	Shaley Limestone With Small Clay Seams
23.0 to 27.0	892.9 to 888.9	1.5	N.R.	Shale and Chert With Large Clay Seams
27.0 to 33.5	888.9 to 882.4	4.0	60	Fractured Cherty Limestone
33.5 to 42.4	882.4 to 873.5	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 903.6	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	903.6 to 888.9	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty Limestone/ Strong Rock	888.9 to Bottom of Pier	150	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	97
Grid Line Location:	4-F
Top Elevation (ft.):	915.3
Total Depth (ft.):	37.1
Bottom of Boring Elevation (ft.):	878.2

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.8	N.R.	N.R.	Clay
2.5 to 14.0	912.8 to 901.3	N.R.	N.R.	
14.0 to 16.0	901.3 to 899.3	1.5	N.R.	Shale and Shaley Limestone
16.0 to 21.5	899.3 to 893.8	5.0	100	Shaley Limestone
21.5 to 37.1	893.8 to 878.2	5.0	50	Shaley/Cherty Limestone With Small Clay Seams

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 905.5	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	905.5 to 899.3	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty & Shaley Limestone/ Strong Rock	899.3 to Bottom of Pier	150	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	98
Grid Line Location:	5-F
Top Elevation (ft.):	914.9
Total Depth (ft.):	37.3
Bottom of Boring Elevation (ft.):	877.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.4	N.R.	N.R.	Cherty Clay
2.5 to 14.0	912.4 to 900.9	N.R.	N.R.	
14.0 to 22.0	900.9 to 892.9	1.0	N.R.	Shale and Shaley Limestone With Large Clay Seams
22.0 to 25.0	892.9 to 889.9	5.0	100	Shaley Limestone/Limestone
25.0 to 31.5	889.9 to 883.4	5.0	N.R.	Shaley Limestone/Limestone
31.5 to 33.5	883.4 to 881.4	4.0	4	Cherty Limestone With Small Clay Seams
33.5 to 37.3	881.4 to 877.6	5.0	4	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 900.9	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	900.9 to 892.9	130	Unconfined Compressive Strength (psi)			
			1,500			
Cherty Limestone/ Strong Rock	892.9 to Bottom of Pier	150	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	99
Grid Line Location:	6-F
Top Elevation (ft.):	914.9
Total Depth (ft.):	51.8
Bottom of Boring Elevation (ft.):	863.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.4	N.R.	N.R.	Cherty Clay/Clay
2.5 to 17.0	912.4 to 897.9	N.R.	N.R.	
17.0 to 30.5	897.9 to 884.4	2.0	N.R.	Shaley Limestone With Wash Away Material
30.5 to 34.0	884.4 to 880.9	5.0	60	Cherty Limestone
34.0 to 40.0	880.9 to 874.9	5.0	N.R.	Cherty Limestone Above Wash Away Zone
40.0 to 46.0	874.9 to 868.9	2.0	N.R.	Cherty Limestone With Wash Away and Highly Weathered Zones
46.0 to 51.8	868.9 to 863.1	5.0	60	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 897.9	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	897.9 to Bottom of Pier	135	Unconfined Compressive Strength (psi)			
			2,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	100
Grid Line Location:	7-F
Top Elevation (ft.):	915.2
Total Depth (ft.):	31.8
Bottom of Boring Elevation (ft.):	883.4

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.7	N.R.	N.R.	Clay
2.5 to 14.5	912.7 to 900.7	N.R.	N.R.	
14.5 to 17.0	900.7 to 898.2	3.5	N.R.	Shale and Shaley Limestone
17.0 to 31.8	898.2 to 883.4	5.0	100	Shaley/Cherty Limestone

- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 900.7	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	900.7 to 898.2	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty Limestone/ Strong Rock	898.2 to Bottom of Pier	150	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	101
Grid Line Location:	8-F
Top Elevation (ft.):	915.6
Total Depth (ft.):	33.8
Bottom of Boring Elevation (ft.):	881.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.1	N.R.	N.R.	Clay, Trace Limestone
2.5 to 9.0	913.1 to 906.6	N.R.	N.R.	
9.0 to 24.0	906.6 to 891.6	2.0	N.R.	Limestone and Large Clay Seam
24.0 to 33.8	891.6 to 881.8	5.0	100	Limestone and Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 906.6	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	906.6 to 897.1	135	Unconfined Compressive Strength (psi)			
			2,000			
Soft Clay	897.1 to 891.6	115	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
			500	150	N/A	0.010
Cherty Limestone/ Strong Rock	891.6 to Bottom of Pier	150	Unconfined Compressive Strength (psi)			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	102
Grid Line Location:	10-F
Top Elevation (ft.):	915.4
Total Depth (ft.):	37
Bottom of Boring Elevation (ft.):	878.4

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.9	N.R.	N.R.	Clay
2.5 to 20.5	912.9 to 894.9	N.R.	N.R.	
20.5 to 26.5	894.9 to 888.9	4.0	N.R.	Shale and Shaley Limestone
26.5 to 37	888.9 to 878.4	5.0	100	Cherty Limestone With

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Soft Clay	1 Pier Diameter to 894.9	125	500	150	N/A	0.010
Shaley Limestone and Shale/ Strong Rock	894.9 to 888.9	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty Limestone/ Strong Rock	888.9 to Bottom of Pier	150	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	104
Grid Line Location:	1-E
Top Elevation (ft.):	916.8
Total Depth (ft.):	63.8
Bottom of Boring Elevation (ft.):	853.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.3	0.5	N.R.	Clay/Cherty Clay
2.5 to 24.0	914.3 to 892.8	0.75	N.R.	
24.0 to 28.0	892.8 to 888.8	1.5	N.R.	
28.0 to 35.5	888.8 to 881.3	1.5	N.R.	Intermittent Chert and Clay Seams
35.5 to 37.0	881.3 to 879.8	2.0	8.0	
37.0 to 43.5	879.8 to 873.3	2.0	N.R.	
43.5 to 56.0	873.3 to 860.8	1.5	N.R.	
56.0 to 63.8	860.8 to 853.0	1.5	20.0	Chert

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 892.8	125	1,000	500	200	0.007
Stiff Clay Without Free	892.8 to 860.8	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	Below 860.8	135	4,000	2,000	800	0.004

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	105
Grid Line Location:	2-E
Top Elevation (ft.):	916.2
Total Depth (ft.):	47.1
Bottom of Boring Elevation (ft.):	869.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.7	N.R.	N.R.	Gravelly Clay / Clay
2.5 to 26.0	913.7 to 890.2	N.R.	N.R.	
26.0 to 38.5	890.2 to 877.7	3.0	N.R.	Weathered and Highly Fractured Cherty Limestone with Wash Away Zones
38.5 to 47.1	877.7 to 869.1	5.0	70	Fractured Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 890.2	125	1,000	500	200	0.005
Weathered Cherty Limestone/ Strong Rock	890.2 to 877.7	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty Limestone/ Strong Rock	877.7 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	106
Grid Line Location:	3-E
Top Elevation (ft.):	915.8
Total Depth (ft.):	41.8
Bottom of Boring Elevation (ft.):	874.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.3	N.R.	N.R.	Clay/Cherty Clay
2.5 to 21.5	913.3 to 894.3	N.R.	N.R.	
21.5 to 24.0	894.3 to 891.8	1.5	N.R.	Shale/ Shaley Limestone
24.0 to 31.5	891.8 to 884.3	3.5	50	Weathered Shaley Limestone
31.5 to 41.2	884.3 to 874.0	5.0	80	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 894.3	125	1,000	500	200	0.007
Shaley Limestone and Shale/ Strong Rock	894.3 to 891.8	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty Limestone/ Strong Rock	891.8 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	107
Grid Line Location:	4-E
Top Elevation (ft.):	915.2
Total Depth (ft.):	36.8
Bottom of Boring Elevation (ft.):	878.4

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.7	N.R.	N.R.	Clay
2.5 to 14.0	912.7 to 901.2	N.R.	N.R.	
14.0 to 18.5	901.2 to 896.7	2.5	N.R.	Shale to Shaley Limestone
18.5 to 22.0	896.7 to 893.2	N.R.	N.R.	Wash Away Zone
22.0 to 25.0	893.2 to 890.2	5.0	100	Shaley Limestone
25.0 to 32.0	890.2 to 883.2	5.0	60	Shaley Limestone to Weathered Shaley Limestone
32.0 to 36.8	883.2 to 878.4	5.0	80	Fractured Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 901.2	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	901.2 to 893.2	135	Unconfined Compressive Strength (psi)			
			1,500			
Shaley & Cherty Limestone/ Strong Rock	893.2 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	108
Grid Line Location:	5-E
Top Elevation (ft.):	915.8
Total Depth (ft.):	34.3
Bottom of Boring Elevation (ft.):	881.5

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.3	N.R.	N.R.	Clay
2.5 to 11.1	913.3 to 904.7	N.R.	N.R.	
11.1 to 18.0	904.7 to 897.8	3.5	40	Weathered Shaley Limestone
18.0 to 19.5	897.8 to 896.3	5.0	100	Limestone
19.5 to 29.5	896.3 to 886.3	3.5	N.R.	Weathered Shaley Limestone
29.5 to 34.3	886.3 to 881.5	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 904.7	125	1,000	500	200	0.007
Shaley Limestone/ Strong Rock	904.7 to 897.8	135	Unconfined Compressive Strength (psi)			
			2,000			
Shaley & Cherty Limestone	897.8 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	109
Grid Line Location:	6-E
Top Elevation (ft.):	914.3
Total Depth (ft.):	29.3
Bottom of Boring Elevation (ft.):	885.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 911.8	N.R.	N.R.	Clean Clay
2.5 to 9.3	911.8 to 905.0	N.R.	N.R.	
9.3 to 15.5	905.0 to 898.8	3.0	40	Weathered Shaley Limestone
15.5 to 16.5	898.8 to 897.8	5.0	100	Shaley Limestone
16.5 to 23.5	897.9 to 890.8	5.0	60	Fractured Shaley Limestone
23.5 to 29.3	890.8 to 885.0	5.0	100	Shaley Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 905.0	125	2,000	1,000	400	0.005
Weathered Shaley Limestone/ Strong Rock	905.0 to 899.3	135	Unconfined Compressive Strength (psi)			
			2,000			
Shaley Limestone/ Strong Rock	899.3 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	110
Grid Line Location:	7-E
Top Elevation (ft.):	914.4
Total Depth (ft.):	34.2
Bottom of Boring Elevation (ft.):	880.2

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 911.9	N.R.	N.R.	Clay
2.5 to 8.5	911.9 to 905.9	N.R.	N.R.	
8.5 to 16.5	905.9 to 897.9	1.5	N.R.	Shaley Limestone
16.5 to 23.0	897.9 to 891.4	N.R.	N.R.	**VOID**
23.0 to 34.2	891.4 to 880.2	4.0	100	Shaley Limestone To Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 905.9	125	1,000	500	200	0.007
Shaley Limestone/ Strong Rock	905.9 to 897.9	135	**Unconfined Compressive Strength (psi)**			
			2,000			
VOID	897.9 to 891.4	0	0			
Shaley & Cherty Limestone/ Strong Rock	891.4 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	111
Grid Line Location:	8-E
Top Elevation (ft.):	914.8
Total Depth (ft.):	29.2
Bottom of Boring Elevation (ft.):	885.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.3	N.R.	N.R.	Clay
2.5 to 9.2	912.3 to 905.6	N.R.	N.R.	
9.2 to 14.0	905.6 to 900.8	3.5	N.R.	Weathered Shaley Limestone
14.0 to 29.2	900.8 to 885.6	5.0	100	Shaley Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 905.6	125	4,000	2,000	800	0.005
Weathered Shaley Limestone/ Strong Rock	905.6 to 900.8	135	Unconfined Compressive Strength (psi)			
			2,000			
Shaley Limestone/ Strong Rock	900.8 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	112
Grid Line Location:	10-E
Top Elevation (ft.):	915.2
Total Depth (ft.):	34.2
Bottom of Boring Elevation (ft.):	881.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.7	N.R.	N.R.	Clay
2.5 to 8.5	912.7 to 906.7	N.R.	N.R.	
8.5 to 15.5	906.7 to 899.7	2.5	N.R.	Shaley Limestone
15.5 to 18.0	899.7 to 897.2	0	N.R.	Probable Void
18.0 to 21.0	897.2 to 894.2	2.5	N.R.	Shaley Limestone With Wash Away Material
21.0 to 34.2	894.2 to 881.0	4.0	80	Shaley/Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 906.7	125	4,000	2,000	800	0.005
Shaley Limestone/ Strong Rock	906.7 to 894.2	135	Unconfined Compressive Strength (psi)			
			2,000			
Shaley and Cherty Limestone/ Strong Rock	894.2 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	114
Grid Line Location:	1-D
Top Elevation (ft.):	916.6
Total Depth (ft.):	51.9
Bottom of Boring Elevation (ft.):	864.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.1	N.R.	N.R.	Cherty Clay/Clay
2.5 to 13.5	914.1 to 903.1	N.R.	N.R.	
13.5 to 18.0	903.1 to 898.6	4.0	60	Shaley Limestone
18.0 to 24.3	898.6 to 892.3	4.0	N.R.	
24.3 to 26.0	892.3 to 890.6	1.0	N.R.	Weathered Shaley Limestone and
26.0 to 34.0	890.6 to 882.6	5.0	100	Limestone With Chert
34.0 to 40.0	882.6 to 876.6	5.0	N.R.	
40.0 to 51.9	876.6 to 864.7	1.0	N.R.	Cherty Limestone With Wash Away Materials

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 903.1	125	2,000	1,000	400	0.005
Shaley and Cherty Limestone/ Strong Rock	903.1 to 876.6	145	Unconfined Compressive Strength (psi)			
			4,000			
Cherty Limestone With Wash Away	876.6 to Bottom of Pier	125	1,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	115
Grid Line Location:	2-D
Top Elevation (ft.):	915.9
Total Depth (ft.):	43.2
Bottom of Boring Elevation (ft.):	872.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.4	N.R.	N.R.	Clay/Cherty Clay
2.5 to 27.5	913.4 to 888.4	N.R.	N.R.	
27.5 to 43.2	888.4 to 872.7	4.0	40	Chert

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 888.4	125	1,000	500	200	0.007
Chert/ Strong Rock	888.4 to Bottom of Pier	135	Unconfined Compressive Strength (psi)			
			2,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	116
Grid Line Location:	3-D
Top Elevation (ft.):	915.5
Total Depth (ft.):	42.2
Bottom of Boring Elevation (ft.):	873.3

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.0	N.R.	N.R.	Clay
2.5 to 14.5	913.0 to 901.0	N.R.	N.R.	
14.5 to 16.5	901.0 to 899.0	1.5	N.R.	Shale
16.5 to 17.5	899.0 to 898.0	4.0	100	Shaley Limestone
17.5 to 24.0	898.0 to 891.5	4.0	N.R.	Shaley Limestone Over Wash Away
24.0 to 25.5	891.5 to 890.0	1.5	N.R.	Wash Away
25.5 to 30.0	890.0 to 885.5	4.0	50	Weathered Shaley Limestone
30.0 to 32.0	885.5 to 883.5	5.0	100	Cherty Limestone
32.0 to 38.0	883.5 to 877.5	5.0	40	
38.0 to 40.0	877.5 to 875.5	3.0	40	Weathered Cherty Limestone
40.0 to 42.2	875.5 to 873.3	5.0	40	Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 901.0	125	1,000	500	200	0.007
Shaley & Cherty Limestone / Strong Rock	901.0 to Bottom of Pier	145	Unconfined Compressive Strength (psi)			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	117
Grid Line Location:	4-D
Top Elevation (ft.):	915
Total Depth (ft.):	26.8
Bottom of Boring Elevation (ft.):	888.2

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.5	N.R.	N.R.	Clay
2.5 to 11.0	912.5 to 904.0	N.R.	N.R.	
11.0 to 16.5	904.0 to 898.5	2.5	40	Weathered Shaley Limestone
16.5 to 26.8	898.5 to 888.2	5.0	100	Shaley Limestone/Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 904.0	125	1,000	500	200	0.007
Shaley Limestone/ Strong Rock	904.0 to 898.5	135	Unconfined Compressive Strength (psi)			
			2,000			
Shaley Limestone/ Strong Rock	898.5 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	118
Grid Line Location:	5-D
Top Elevation (ft.):	914.5
Total Depth (ft.):	34.4
Bottom of Boring Elevation (ft.):	880.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.0	N.R.	N.R.	Clay
2.5 to 12.0	912.0 to 902.5	N.R.	N.R.	
12.0 to 18.5	902.5 to 896.0	2	40	Weathered Shaley Limestone
18.5 to 24.0	896.0 to 890.5	3.5	N.R.	Limestone
24.0 to 28.0	890.5 to 886.5	1.5	N.R.	Weathered Shaley Limestone With Wash Away
28.0 to 34.4	886.5 to 880.1	5.0	60	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 902.5	125	1,000	500	200	0.007
Shaley Limestone/ Strong Rock	902.5 to 886.5	135	Unconfined Compressive Strength (psi)			
			2,000			
Shaley & Cherty Limestone/ Strong Rock	886.5 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	119
Grid Line Location:	6-D
Top Elevation (ft.):	914.1
Total Depth (ft.):	24.3
Bottom of Boring Elevation (ft.):	889.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 911.6	N.R.	N.R.	Clay
2.5 to 11.3	911.6 to 902.8	N.R.	N.R.	
11.3 to 16.5	902.8 to 897.6	3.5	N.R.	Weathered Shaley Limestone
16.5 to 24.3	897.6 to 889.8	5.0	100	Shaley Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 902.8	125	1,000	500	200	0.007
Weathered Shaley Limestone/ Strong Rock	902.8 to 897.6	135	Unconfined Compressive Strength (psi)			
			2,000			
Shaley Limestone/ Strong Rock	897.6 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	120
Grid Line Location:	7-D
Top Elevation (ft.):	913.9
Total Depth (ft.):	34.3
Bottom of Boring Elevation (ft.):	879.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 911.4	N.R.	N.R.	Clean Clay
2.5 to 10.0	911.4 to 903.9	N.R.	N.R.	
10.0 to 16.0	903.9 to 897.9	1.5	N.R.	Shaley Limestone With Wash Away Zones
16.0 to 17.5	897.9 to 896.4	5.0	100	Shaley Limestone
17.5 to 24.5	896.4 to 889.4	4.0	N.R.	Shaley Limestone With Was Away Zone
24.5 to 34.3	889.4 to 879.6	5.0	100	Shaley Limestone to Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 903.9	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	903.9 to Bottom of Pier	145	Unconfined Compressive Strength (psi)			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	121
Grid Line Location:	8-D
Top Elevation (ft.):	914.1
Total Depth (ft.):	29.3
Bottom of Boring Elevation (ft.):	884.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 911.9	N.R.	N.R.	Clay
2.5 to 14.0	911.9 to 902.4	N.R.	N.R.	
14.0 to 29.3	902.4 to 884.8	5.0	100	Shaley to Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Soft Clay	1 Pier Diameter to 902.4	125	500	30	N/A	0.020
Shaley Limestone and Chert/ Strong Rock	902.4 to Bottom of Pier	145	Unconfined Compressive Strength (psi)			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	122
Grid Line Location:	10-D
Top Elevation (ft.):	914.4
Total Depth (ft.):	29.3
Bottom of Boring Elevation (ft.):	885.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 911.9	N.R.	N.R.	Clay
2.5 to 12.0	911.9 to 902.4	N.R.	N.R.	
12.0 to 29.3	902.4 to 885.1	5.0	100	Shaley & Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 902.4	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	902.4 to Bottom of Pier	145	Unconfined Compressive Strength (psi)			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	124
Grid Line Location:	1-C
Top Elevation (ft.):	916.6
Total Depth (ft.):	46.8
Bottom of Boring Elevation (ft.):	869.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.1	N.R.	N.R.	Clay
2.5 to 13.0	914.1 to 903.6	N.R.	N.R.	
13.0 to 25.0	903.6 to 891.6	N.R.	N.R.	Shale to Shaley Limestone with Wash Away
25.0 to 27.5	891.6 to 889.1	5.0	100	Cherty Limestone
27.5 to 34.0	889.1 to 882.6	5.0	N.R.	
34.0 to 35.0	882.6 to 881.6	1.5	N.R.	Limestone with Clay Seam
35.0 to 46.8	881.6 to 869.8	5.0	100	Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 903.6	125	2,000	1,000	400	0.005
Stiff Clay Without Free Water	903.6 to 892.1	125	4,000	2,000	800	0.004
Shaley & Cherty Limestone/ Strong Rock	892.1 to Bottom of Pier	145	Unconfined Compressive Strength (psi)			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	125
Grid Line Location:	2-C
Top Elevation (ft.):	915.9
Total Depth (ft.):	36.7
Bottom of Boring Elevation (ft.):	879.2

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.4	N.R.	N.R.	Clay
2.5 to 12.5	913.4 to 903.4	N.R.	N.R.	
12.5 to 15.0	903.4 to 900.9	1.5	N.R.	Shale
15.0 to 18.0	900.9 to 897.9	2.0	N.R.	Shaley Limestone
18.0 to 21.0	897.9 to 894.9	0	N.R.	**Void**
21.0 to 25.0	894.9 to 890.9	5.0	100	Shaley Limestone
25.0 to 33.0	890.9 to 882.9	3.0	60	Weathered Shaley Limestone
33.0 to 36.7	882.9 to 879.2	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 903.4	125	1,000	500	200	0.007
Shaley & Cherty Limestone/ Strong Rock	903.4 to Bottom of Pier	145	**Unconfined Compressive Strength (psi)**			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	126
Grid Line Location:	3-C
Top Elevation (ft.):	915.5
Total Depth (ft.):	36.9
Bottom of Boring Elevation (ft.):	878.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.0	N.R.	N.R.	Clay
2.5 to 12.5	913.0 to 903.0	N.R.	N.R.	
12.5 to 22.5	903.0 to 893.0	3.5	N.R.	Weathered Shaley/Cherty Limestone
22.5 to 28.5	893.0 to 887.0	3.5	40	Weathered Shaley/Cherty Limestone
28.5 to 36.9	887.0 to 878.6	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 903.0	125	1,000	500	200	0.007
Shaley & Cherty Limestone/ Strong Rock	903.0 to 887.0	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty Limestone/ Strong Rock	887.0 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	127
Grid Line Location:	4-C
Top Elevation (ft.):	914.9
Total Depth (ft.):	39.8
Bottom of Boring Elevation (ft.):	875.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.4	N.R.	N.R.	Clay
2.5 to 9.8	912.4 to 905.1	N.R.	N.R.	
9.8 to 17.0	905.1 to 897.9	2.0	N.R.	Weathered Shaley Limestone
17.0 to 19.5	897.9 to 895.4	0	N.R.	**VOID**
19.5 to 30.0	895.4 to 884.9	3.5	40	Shaley Limestone With Wash away Zones
30.0 to 39.8	884.9 to 875.1	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 905.1	125	1,000	500	200	0.007
Shaley Limestone/ Strong Rock	905.1 to 884.9	135	**Unconfined Compressive Strength (psi)**			
			2,000			
Shaley & Cherty Limestone/ Strong Rock	884.9 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	128
Grid Line Location:	5-C
Top Elevation (ft.):	914.4
Total Depth (ft.):	33.8
Bottom of Boring Elevation (ft.):	880.6

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 911.9	N.R.	N.R.	Cherty Clay / Clay
2.5 to 22.4	911.9 to 892.0	N.R.	N.R.	
22.4 to 24.5	892.0 to 889.9	2.5	N.R.	Shaley Limestone with Wash Away
24.5 to 27.0	889.9 to 887.4	4.0	40	Shaley Limestone
27.0 to 33.8	887.4 to 880.6	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 892.0	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	892.0 to Bottom of Pier	145	Unconfined Compressive Strength (psi)			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	129
Grid Line Location:	6-C
Top Elevation (ft.):	913.9
Total Depth (ft.):	34.5
Bottom of Boring Elevation (ft.):	879.4

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 911.4	N.R.	N.R.	Clay
2.5 to 14.5	911.4 to 899.4	N.R.	N.R.	
14.5 to 15.3	899.4 to 898.6	1.0	N.R.	Shaley Limestone
15.3 to 17.0	898.6 to 896.9	N.R.	N.R.	**VOID**
17.0 to 18.0	896.9 to 895.9	3.5	40	Fractured Shaley Limestone
18.0 to 24.0	895.9 to 889.9	3.5	N.R.	Shaley Limestone Above Wash Away
24.0 to 25.5	889.9 to 888.4	1.0	N.R.	Highly Weathered Shale/Wash Away
25.5 to 34.5	888.4 to 879.4	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 896.9	125	1,000	500	200	0.007
Shaley Limestone/ Strong Rock	896.9 to 888.4	135	**Unconfined Compressive Strength (psi)**			
			2,000			
Cherty Limestone/ Strong Rock	888.4 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	130
Grid Line Location:	7-C
Top Elevation (ft.):	913.6
Total Depth (ft.):	29.4
Bottom of Boring Elevation (ft.):	884.2

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 911.1	N.R.	N.R.	Clay
2.5 to 14.4	911.1 to 899.2	N.R.	N.R.	
14.4 to 20.5	899.2 to 893.1	3.5	40	Shaley Limestone
20.5 to 29.4	893.1 to 884.2	5.0	100	Shaley/Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 899.2	125	1,000	500	200	0.007
Shaley & Cherty Limestone/ Strong Rock	899.2 to Bottom of Pier	145	Unconfined Compressive Strength (psi)			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	131
Grid Line Location:	8-C
Top Elevation (ft.):	913.2
Total Depth (ft.):	34.5
Bottom of Boring Elevation (ft.):	878.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 910.7	N.R.	N.R.	Clay
2.5 to 14.5	910.7 to 898.7	N.R.	N.R.	
14.5 to 18.5	898.7 to 894.7	4.0	100	Shaley Limestone
18.5 to 24.0	894.7 to 889.2	4.0	50	Shaley Limestone
24.0 to 26.5	889.2 to 886.7	2.0	20	Highly Weathered Shaley Limestone
26.5 to 34.5	886.7 to 878.7	5.0	100	Shaley/Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 898.7	125	1,000	500	200	0.007
Shaley & Cherty Limestone and Shale/ Strong Rock	898.7 to Bottom of Pier	145	Unconfined Compressive Strength (psi)			
			4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	132
Grid Line Location:	10-C
Top Elevation (ft.):	913.4
Total Depth (ft.):	27.9
Bottom of Boring Elevation (ft.):	885.5

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 910.9	N.R.	N.R.	Clay
2.5 to 15.9	910.9 to 897.5	N.R.	N.R.	
15.9 to 22.5	897.5 to 890.9	3.5	60	Shaley Limestone
22.5 to 27.9	890.9 to 885.5	5.0	100	Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 897.5	125	1,000	500	200	0.007
Shaley Limestone/ Strong Rock	897.5 to 890.9	135	Unconfined Compressive Strength (psi)			
			2,000			
Limestone/ Strong Rock	890.9 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	133
Grid Line Location:	1-B.3
Top Elevation (ft.):	916.4
Total Depth (ft.):	37
Bottom of Boring Elevation (ft.):	879.4

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.9	N.R.	N.R.	Clay
2.5 to 9.3	913.9 to 907.1	N.R.	N.R.	
9.3 to 28.0	907.1 to 888.4	1.5	N.R.	Shaley Limestone/Limestone with Wash Away Zones
28.0 to 37.0	888.4 to 879.4	5.0	100	Shaley & Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 907.1	125	2,000	1,000	400	0.005
Shaley Limestone/ Strong Rock	907.1 to 888.4	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty & Shaley Limestone/ Strong Rock	888.4 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	134
Grid Line Location:	1-B
Top Elevation (ft.):	916.5
Total Depth (ft.):	31.8
Bottom of Boring Elevation (ft.):	884.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.0	N.R.	N.R.	Cherty Clay/Clay
2.5 to 17.3	914.0 to 899.2	N.R.	N.R.	
17.3 to 20.0	899.2 to 896.5	2.0	N.R.	Shaley Limestone
20.0 to 22.0	896.5 to 894.5	N.R.	N.R.	**VOID**
22.0 to 31.8	894.5 to 884.7	5.0	100	Shaley Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 899.2	125	1,000	500	200	0.007
Shaley Limestone/ Strong Rock	899.2 to 895.0	135	**Unconfined Compressive Strength (psi)**			
			2,000			
Shaley Limestone/ Strong Rock	895.0 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	135
Grid Line Location:	2-B
Top Elevation (ft.):	915.8
Total Depth (ft.):	36.8
Bottom of Boring Elevation (ft.):	879.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.3	N.R.	N.R.	Clay
2.5 to 14.3	913.3 to 901.5	N.R.	N.R.	
14.3 to 16.5	901.5 to 899.3	3.0	50	Weathered Shaley Limestone
16.5 to 18.5	899.3 to 897.3	5.0	100	Shaley Limestone
18.5 to 25.5	897.3 to 890.3	4.0	60	Shaley Limestone with Weathered Shale Seam
25.5 to 36.8	890.3 to 879.0	5.0	100	Shaley to Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 901.5	125	1,000	500	200	0.007
Shaley Limestone/ Strong Rock	901.5 to 899.3	135	Unconfined Compressive Strength (psi)			
			2,000			
Shaley & Cherty Limestone/ Strong Rock	899.3 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	136
Grid Line Location:	3-B
Top Elevation (ft.):	915.3
Total Depth (ft.):	36.8
Bottom of Boring Elevation (ft.):	878.5

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.8	N.R.	N.R.	Cherty Clay/Clay
2.5 to 12.8	912.8 to 902.5	N.R.	N.R.	
12.8 to 17.0	902.5 to 898.3	1.5	N.R.	Shaley Limestone/Shale
17.0 to 21.0	898.3 to 894.3	N.R.	N.R.	**VOID**/Clay Seam
21.0 to 25.5	894.3 to 889.8	5.0	100	Limestone
25.5 to 31.5	889.8 to 883.8	5.0	40	Shaley/Cherty Limestone
31.5 to 32.5	883.8 to 882.8	1.5	40	Highly Weathered Cherty Limestone
32.5 to 36.8	882.8 to 878.5	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 902.5	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	902.5 to 898.3	135	Unconfined Compressive Strength (psi)			
			1,500			
VOID	898.3 to 894.3	0	0			
Cherty Limestone/ Strong Rock	894.3 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	137
Grid Line Location:	4-B
Top Elevation (ft.):	914.7
Total Depth (ft.):	39.9
Bottom of Boring Elevation (ft.):	874.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.2	N.R.	N.R.	Cherty Clay/Clay
2.5 to 15.6	912.2 to 899.1	N.R.	N.R.	
15.6 to 16.6	899.1 to 898.1	1.0	N.R.	Shale
16.6 to 21.0	898.1 to 893.7	N.R.	N.R.	**VOID**
21.0 to 29.5	893.7 to 885.2	4.0	N.R.	Shaley Limestone/Limestone with Wash Away
29.5 to 39.9	885.2 to 874.8	5.0	80	Limestone to Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 898.1	125	2,000	1,000	400	0.005
VOID	898.1 to 893.7	0	0			
Shaley Limestone and Shale/ Strong Rock	893.7 to 885.5	135	**Unconfined Compressive Strength (psi)**			
			2,000			
Cherty Limestone/ Strong Rock	885.5 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	138
Grid Line Location:	5-B
Top Elevation (ft.):	914.2
Total Depth (ft.):	41.8
Bottom of Boring Elevation (ft.):	872.4

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 911.7	N.R.	N.R.	Cherty Clay
2.5 to 23.0	911.7 to 891.2	N.R.	N.R.	
23.0 to 26.5	891.2 to 887.7	1.5	N.R.	Shaley Limestone and Wash Away
26.5 to 31.0	887.7 to 883.2	3.0	N.R.	Fractured Cherty Limestone
31.0 to 41.8	883.2 to 872.4	5.0	80	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 891.2	125	4,000	2,000	800	0.004
Shaley Limestone and Shale/ Strong Rock	891.2 to 887.7	135	Unconfined Compressive Strength (psi)			
			1,500			
Cherty Limestone/ Strong Rock	887.7 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	139
Grid Line Location:	6-B
Top Elevation (ft.):	913.6
Total Depth (ft.):	39.5
Bottom of Boring Elevation (ft.):	874.1

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 911.1	N.R.	N.R.	Clay/Shale
2.5 to 21.9	911.1 to 891.7	N.R.	N.R.	
21.9 to 24.0	891.7 to 889.6	2.5	N.R.	Shaley Limestone
24.0 to 32.5	889.6 to 881.1	3.5	50	Weathered Cherty Limestone
32.5 to 39.5	881.1 to 874.1	5	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 891.7	125	1,000	500	200	0.007
Shaley Limestone/ Strong Rock	891.7 to 881.1	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty Limestone/ Strong Rock	881.1 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	140
Grid Line Location:	7-B
Top Elevation (ft.):	913.2
Total Depth (ft.):	37
Bottom of Boring Elevation (ft.):	876.2

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 910.7	N.R.	N.R.	Clay
2.5 to 21.3	910.7 to 891.9	N.R.	N.R.	
21.3 to 26.5	891.9 to 886.7	5.0	60	Shaley Limestone
26.5 to 37.0	886.7 to 876.2	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 891.9	125	1,000	500	200	0.007
Shaley Limestone/ Strong Rock	891.9 to 886.7	135	Unconfined Compressive Strength (psi)			
			2,000			
Cherty Limestone/ Strong Rock	886.7 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	141
Grid Line Location:	8-B
Top Elevation (ft.):	912.6
Total Depth (ft.):	29.8
Bottom of Boring Elevation (ft.):	882.8

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 910.1	N.R.	N.R.	Clean Clay
2.5 to 18.3	910.1 to 894.3	N.R.	N.R.	
18.3 to 22.5	894.3 to 890.1	3.5	40	Shaley Limestone/Shale
22.5 to 29.8	890.1 to 882.8	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 894.3	125	1,000	500	200	0.007
Shaley Limestone and Shale/ Strong Rock	894.3 to 890.1	135	Unconfined Compressive Strength (psi)			
			1,500			
Cherty Limestone/ Strong Rock	890.1 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	143
Grid Line Location:	3-A.6
Top Elevation (ft.):	915.1
Total Depth (ft.):	32.9
Bottom of Boring Elevation (ft.):	882.2

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.6	N.R.	N.R.	Cherty Clay/Clay
2.5 to 12.9	912.6 to 902.2	N.R.	N.R.	
12.9 to 18.0	902.2 to 897.1	2.5	N.R.	Shaley Limestone
18.0 to 23.0	897.1 to 892.1	N.R.	N.R.	**VOID**
23.0 to 32.9	892.1 to 882.2	5.0	75	Shaley/Chert Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 902.2	125	2,000	1,000	400	0.005
Shaley Limestone/ Strong Rock	902.2 to 897.1	135	**Unconfined Compressive Strength (psi)**			
			2,000			
VOID	897.1 to 892.1	0	0			
Shaley & Cherty Limestone/ Strong Rock	892.1 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	144
Grid Line Location:	2-A
Top Elevation (ft.):	915.6
Total Depth (ft.):	36.9
Bottom of Boring Elevation (ft.):	878.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.1	N.R.	N.R.	Clay
2.5 to 14.0	913.1 to 901.6	N.R.	N.R.	
14.0 to 19.0	901.6 to 896.6	2.0	N.R.	Weathered Shale and Shaley Limestone
19.0 to 24.5	896.6 to 891.1	N.R.	N.R.	**VOID**/Clay Seam
24.5 to 26.0	891.1 to 889.6	3.0	40	Weathered Shaley Limestone
26.0 to 31.5	889.6 to 884.1	3.5	60	Shaley Limestone
31.5 to 36.9	884.1 to 878.7	5.0	100	Shaley to Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 901.6	125	1,000	500	200	0.007
Shaley Limestone and Shale/ Strong Rock	901.6 to 896.6	135	**Unconfined Compressive Strength (psi)**			
			1,500			
VOID	896.6 to 891.1	0	0			
Shaley & Cherty Limestone/ Strong Rock	891.1 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	145
Grid Line Location:	4-A
Top Elevation (ft.):	914.5
Total Depth (ft.):	29.8
Bottom of Boring Elevation (ft.):	884.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.0	N.R.	N.R.	Clay
2.5 to 14.0	912.0 to 900.5	N.R.	N.R.	
14.0 to 16.0	900.5 to 898.5	1.5	N.R.	Weathered Shale & Limestone
16.0 to 18.0	898.5 to 896.5	N.R.	N.R.	**VOID**
18.0 to 22.5	896.5 to 892.0	5.0	N.R.	Shaley Limestone/Limestone
22.5 to 24.0	892.0 to 890.5	N.R.	N.R.	Limestone w/ Clay Seam/Wash Away
24.0 to 29.8	890.5 to 884.7	5.0	100	Limestone to Shaley/Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 900.5	125	1,000	500	200	0.007
Shaley Limestone and Limestone/ Strong Rock	900.5 to 896.5	135	**Unconfined Compressive Strength (psi)**			
			1,500			
Shaley & Cherty Limestone/ Strong Rock	896.5 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	146
Grid Line Location:	1-A
Top Elevation (ft.):	916.3
Total Depth (ft.):	39.8
Bottom of Boring Elevation (ft.):	876.5

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.8	N.R.	N.R.	Clay
2.5 to 18.4	913.8 to 897.9	N.R.	N.R.	
18.4 to 20.7	897.9 to 895.6	1.5	N.R.	Limestone
20.7 to 24.8	895.6 to 891.5	N.R.	N.R.	**VOID**
24.8 to 32.0	891.5 to 884.3	3.0	N.R.	Shaley Limestone with Possible **Void** from 29.2 to 29.6
32.0 to 39.8	884.3 to 876.5	5.0	75	Cherty Limestone/Chert

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 897.9	125	1,000	500	200	0.007
Shaley Limestone and Shale/ Strong Rock	897.9 to 895.6	135	**Unconfined Compressive Strength (psi)**			
			2,000			
VOID	895.6 to 891.5	0	0			
Cherty Limestone/ Strong Rock	891.5 to Bottom of Pier	135	3,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	150
Grid Line Location:	3-R
Top Elevation (ft.):	915
Total Depth (ft.):	35.5
Bottom of Boring Elevation (ft.):	879.5

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 912.5	N.R.	N.R.	Cherty Clay/Clay
2.5 to 16.5	912.5 to 898.5	N.R.	N.R.	
16.5 to 19.0	898.5 to 896.0	1.5	N.R.	Shaley Limestone/Shale
19.0 to 20.0	896.0 to 895.0	N.R.	N.R.	**VOID**/Clay Seam
20.0 to 23.5	895.0 to 891.5	2.5	N.R.	Shaley Limestone/Shale
23.5 to 24.7	891.5 to 890.3	N.R.	N.R.	**VOID**/Clay Seam
24.7 to 28.0	890.3 to 887.0	2.5	N.R.	Fractured Cherty Limestone
28.0 to 35.5	887.0 to 879.5	5.0	75	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 898.5	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	898.5 to 887.0	135	Unconfined Compressive Strength (psi)			
			1,500			
Cherty Limestone/ Strong Rock	887.0 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	152
Grid Line Location:	2-R
Top Elevation (ft.):	915.6
Total Depth (ft.):	36.9
Bottom of Boring Elevation (ft.):	878.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.1	N.R.	N.R.	Cherty Clay/Clay
2.5 to 16.0	913.1 to 899.6	N.R.	N.R.	
16.0 to 21.0	899.6 to 894.6	3.5	N.R.	Shaley Limestone/Limestone
21.0 to 23.0	894.6 to 892.6	N.R.	N.R.	**VOID**
23.0 to 27.0	892.6 to 888.6	0.5	N.R.	Clay/Highly Weathered Shale
27.0 to 30.5	888.6 to 885.1	4.0	40	Weathered Cherty Limestone
30.5 to 36.9	885.1 to 878.7	5.0	100	Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 899.6	125	2,000	1,000	400	0.005
Shaley Limestone and Shale/ Strong Rock	899.6 to 894.6	145	**Unconfined Compressive Strength (psi)**			
			2,000			
VOID	894.6 to 892.6	0	0			
Stiff Clay Without Free Water	892.6 to 888.6	125	**Cohesion (psf)**	**Static K_h (pci)**	**Cyclic K_h (pci)**	**e_{50}**
			4,000	2,000	800	0.004
Cherty Limestone/ Strong Rock	888.6 to 885.1	135	**Unconfined Compressive Strength (psi)**			
			2,000			
Cherty Limestone/ Strong Rock	885.1 to Bottom of Pier	145	4,000			

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	154
Grid Line Location:	1-R
Top Elevation (ft.):	916.3
Total Depth (ft.):	41.9
Bottom of Boring Elevation (ft.):	874.4

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 913.8	N.R.	N.R.	Cherty Clay/Clay
2.5 to 17.5	913.8 to 898.8	N.R.	N.R.	
17.5 to 18.5	989.8 to 897.8	1.0	N.R.	Shaley Limestone
18.5 to 26.0	897.8 to 890.3	N.R.	N.R.	**VOID**
26.0 to 28.9	890.3 to 887.4	3.5	N.R.	Cherty Limestone
28.9 to 32.0	887.4 to 884.3	N.R.	N.R.	Wash Away Clay Seam
32.0 to 41.9	884.3 to 874.4	3.5	50	Highly Fractured Cherty Limestone

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 898.8	125	1,000	500	200	0.007
Shaley Limestone and Shale/ Strong Rock	898.8 to 897.8	130	**Unconfined Compressive Strength (psi)**			
			1,500			
VOID	897.8 to 891.1	0	0			
Shale & Cherty Limestone/ Strong Rock	891.1 to 887.4	135	2,000			
Stiff Clay Without Free Water	887.4 to 885.4	90	**Cohesion (psf)**	**Static K_h (pci)**	**Cyclic K_h (pci)**	**e_{50}**
			500	100	N/A	0.010
Cherty Limestone/ Strong Rock	885.4 to Bottom of Pier	145	**Unconfined Compressive Strength (psi)**			
			3,000			

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Pre-Drill Boring Summary

Project: Pier Pre-Drill - WW Hastings Replacement Hospital
Client: Foreman Manhattan
Project #: 280212
Pre Drill Boring #: 163
Grid Line Location: BR-1-BR-B offset 12' East and 3' South
Top Elevation (ft.): 917 +/- 1 foot due to offset
Total Depth (ft.): 37
Bottom of Boring Elevation (ft.): 880.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.5	N.R.	N.R.	Cherty Clay/Clay
2.5 to 22.0	914.5 to 895.0	N.R.	N.R.	
22.0 to 29.0	895.0 to 888.0	3.5	50	Cherty Limestone With Highly Weathered Zones
29.0 to 37.0	888.0 to 880.0	3.5	30	Highly Weathered Cherty Limestone/Wash Away

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 895.0	125	1,000	500	200	0.007
Cherty Limestone/ Strong Rock	895.0 to 884.0	135	Unconfined Compressive Strength (psi)			
			1,500			
Stiff Clay Without Free Water	884.0 to 880.0	125	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
			4,000	2,000	800	0.004

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Pre-Drill Boring Summary

Project:	Pier Pre-Drill - WW Hastings Replacement Hospital
Client:	Foreman Manhattan
Project #:	280212
Pre Drill Boring #:	164
Grid Line Location:	BR-2-BR-B
Top Elevation (ft.):	917.5
Total Depth (ft.):	39.8
Bottom of Boring Elevation (ft.):	877.7

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 915.0	N.R.	N.R.	Cherty Clay/Clay
2.5 to 21.2	915.0 to 896.3	N.R.	N.R.	
21.2 to 25.5	896.3 to 892.5	1.5	N.R.	Shaley/Cherty Limestone With **VOID** From 23.8' to 24.4'
25.5 to 39.8	892.5 to 877.7	5.0	80	Cherty Limestone/Chert

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 896.3	115	500	100	N/A	0.010
Shaley Limestone and Shale/ Strong Rock	896.3 to 893.1	135	**Unconfined Compressive Strength (psi)**			
			1,500			
Cherty Limestone/ Strong Rock	893.1 to Bottom of Pier	145	4,000			

PALMERTON & PARRISH, INC.

4168 W. Kearney St.
Springfield, MO 65803
Ph: (417) 864-6000
www.ppimo.com

Pre-Drill Boring Summary

Project: Pier Pre-Drill - WW Hastings Replacement Hospital
Client: Foreman Manhattan
Project #: 280212
Pre Drill Boring #: 165
Grid Line Location: BR-1-BR-A offset 12' East and 3' South
Top Elevation (ft.): 917 +/- 1 foot due to offset
Total Depth (ft.): 42
Bottom of Boring Elevation (ft.): 875.0

Pre-Drill Information

Applicable Depth (ft.)	Applicable Elevation (ft.)	Allowable Skin Friction (ksf)	Allowable End Bearing (ksf)	General Material
Ground Surface to 1 Pier Diameter or 2.5' whichever is shallower	Up to 914.5	N.R.	N.R.	Cherty Clay/Clay
2.5 to 25.5	914.5 to 891.5	N.R.	N.R.	
25.5 to 31.0	891.5 to 886.0	3.5	50	Cherty Limestone/Chert
31.0 to 42.0	886.0 to 875.0	3.5	30	Chert & Chert Clay Matrix

- Skin friction Should be ignored to a depth of 1 pier diameter below the ground surface
- Pier depth should meet or exceed a D/B ratio of 5 below the ground surface
- End bearing not applicable below a depth of 1.5 times the pier diameter above the bottom of the pre-drill Boring.
- N.R. = Not Recommended
- Skin friction factor of safety of 2
- End bearing factor of safety of 3

Deep Foundation - Lateral Loading

Soil Type	Applicable Elevation (ft.)	Unit Weight (pcf)	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
Stiff Clay Without Free Water	Ground Surface to 1 Pier Diameter	Ignore	Ignore	Ignore	Ignore	Ignore
Stiff Clay Without Free Water	1 Pier Diameter to 892.5	125	2,000	1,000	400	0.005
Cherty Limestone/ Strong Rock	892.5 to 882.5	135	Unconfined Compressive Strength (psi)			
			1,500			
Stiff Clay Without Free Water	882.5 to 875.0	125	Cohesion (psf)	Static K_h (pci)	Cyclic K_h (pci)	e_{50}
			4,000	2,000	800	0.004